THE COAL AND IRON OF SOUTHERN OHIO

CONSIDERED WITH RELATION TO

THE HOCKING VALLEY COAL FIELD

AND

ITS IRON ORES,

WITH NOTICES OF

FURNACE COALS AND IRON SMELTING,

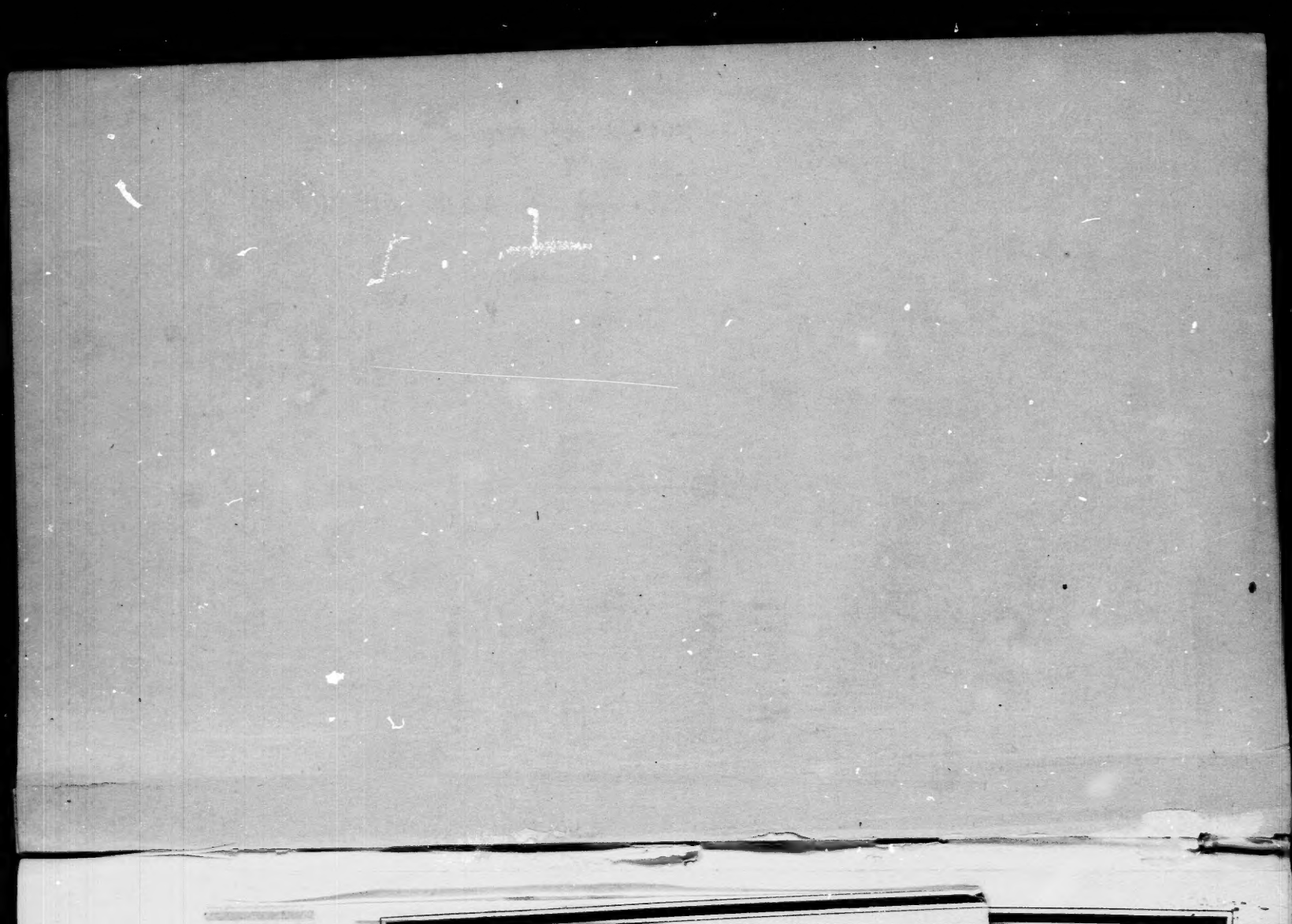
FOLLOWED BY A VIEW OF

THE COAL TRADE OF THE WEST.

BY

T. STERRY HUNT, LL.D., F.R.S.

SALEM, MASS.
NATURALISTS' AGENCY.
1874.




LONG 81
Westminster
Westminster
St Marys
GRAI
Sho
to the Ma
T. S
40


LAKE
MICHIGAN
81 Miles
86 Miles
93 Miles
95 Miles
102 Miles
106 Miles
MILWAUKEE
RACINE
KENOSHA
Waukegan
CHICAGO
GRAND HAVEN
SOUTH HAVEN
New Buffalo
MICHIGAN CITY
OTTAWA
VAN BUREN
KALAMAZOO
ALLEGAN
BERRIEN
CASS
ST JOSEPH
ELKHART
LAPORTE
PORTER
LAKE
JASPER
NEWTON
PULASKI
FULTON
MARSHALL
KOSCIUSKO
STARKE
LOGANSPORT
Allegan
Plainwell
Paw Paw
Lawton
Decatur
Dowagiac
THREE RIVERS
White Pigeon
Niles
Buchanan
Elkhart
Goshen
Mishawaka
South Bend
La Porte
Valparaiso
Crown Point
Plymouth
Rochester
Winamac
Francesville
Rensselaer
Medaryville
Kankakee
St. Anne
Momence
Peotone
Manteno
Matteson
Blue Island
Lemont
Evanston
Wynetka
Glencoe
Highland Park
Half Day
Rockland
Wadsworth
Gurnee
Union Gr.
Windsor
Lake
County Line
Des Plaines
Maywood
Oak Park
Riverside
Calumet
Bremen
Mokena
Frankfort
Crete
Monee
Beecher
Grant
Dyer
Hobart
Liverpool
Wanatah
Westville
Kouts
Hebron
Rolling Prairie
Stillwell
Kankakee
Walkerton
Tyner
Knox
Argos
Bourbon
Warsaw
Leesburg
Ligonier
Millersburg
Bristol
Middlebury
Constantine
Edwardsburgh
Cassopolis
Pokagon
Benton Har.
St Joseph
Coloma
Watervliet
Hartford
Lawrence
Bangor
Breedsville
Geneva
Bradley
Wayland
Hopkins
Gilchrist
Hamilton
Fillmore
Holland
Olive
Grandville
Byron
Moline
Shelby
Martin
Cooper
Mattawan
Schoolcraft
Marcellus
Vicksburg
Leonidas
Centreville
Sturgis
Lima
Wolf Lake
Kankakee R.
Beaver L.
Iroquois R.
Tippecanoe R.
St. Joseph R.
Ashkum
Clifton
Gilman
Danforth
Watseka
Sheldon
Kentland
Goodland
Remington
Wolcott
Monticello
Bradford
Reynolds
State Line
Star City
Rosedale
Royal Center
Fulton
Manchester
Green Oak
Ripley
San Pierre
Shakapee
Roselle
LaCrosse
Rosse
Wheeler
Cassville
Richton
Goodenow
Thornton
Lansing
Gibsons
MICHIGAN CENTRAL
ILLINOIS CENTRAL R.R.
CHICAGO & ROCK ID.
JOLIET CUT OFF
CHICAGO & MILWAUKEE R.R.
PITTSBURGH FT. WAYNE & CHICAGO
LOUISVILLE NEW ALBANY & CHICAGO R.R.
42
41


85 LONGITUDE WEST 84 FROM GREENWICH 83
MICHIGAN
CLINTON
SHIAWASSEE
GENESEE
LIVINGSTON
OAKLAND
MACOMB
INGHAM
EATON
CLINTON
BARRY
IONIA
GRATIOT
JACKSON
WASHTENAW
WAYNE
CALHOUN
KALAMAZOO
CALHOUN
BRANCH
HILLSDALE
LENAWEE
MONROE
ST. JOSEPH
THREE RIVERS
LAGRANGE
STEUBEN
DEKALB
NOBLE
WILLIAMS
FULTON
LUCAS
OTTAWA
CLAY JUNC.
PORT CLINTON
SANDUSKY
FREMONT
SENECA
WOOD
HENRY
DEFIANCE
PAULDING
PUTNAM
ALLEN
HANCOCK
FINDLAY
WYANDOT
CRAWFORD
VAN WERT
ADAMS
WHITLEY
FORT WAYNE
Lansing
Detroit
Jackson
Ann Arbor
Ypsilanti
Pontiac
Flint
Holly
Milford
Howell
Brighton
Marshall
Battle Creek
Kalamazoo
Charlotte
Eaton Rap
Mason
Okemos
Dansville
Portland
Sunfield
Vermontville
Hastings
Nashville
Middleville
Wayland
Caledonia
Sebewa
Bath
Laingsburg
Perry
Shiawassee
Corunna
Owosso
Durand
Fenton
Linden
Grand Blanc
Davisburg
Clarkston
Drayton Plains
Waterford
Oxford
Orion
Rochester
Utica
Troy
Birmingham
Farmington
Royal Oak
Northville
Plymouth
Livonia
Dearborn
Detroit
Wyandotte
Trenton
Monroe
La Salle
Newport
Erie
Toledo
Maumee
Perrysburg
Waterville
Whitehouse
Swanton
Archbold
Stryker
Wauseon
Delta
Fayette
Bryan
Edgerton
Napoleon
Defiance
Florida
Hicksville
Antwerp
Paulding
Emerald Junction
Deshler
Belmore
Leipsic
Ottawa
Kalida
Columbus Gr.
Delphos
Van Wert
Bluffton
Decatur
Monroeville
Roanoke
Huntington
Wabash
Fort Wayne
Auburn
Angola
Coldwater
Sturgis
Centreville
Three Rivers
Constantine
Mendon
Marcellus
Vicksburg
Portage L.
Schoolcraft
Kalamazoo
Climax
Battle Creek
Marshall
Albion
Concord
Jackson
Grass L.
Leoni
Eckford
Clarendon
Homer
Baldwins
Napoleon
Brooklyn
Clinton
Tecumseh
Adrian
Blissfield
Deerfield
Wellsville
Manchester
Saline
Bridgewater
Dexter
Chelsea
Lyndon
Unadilla
Pinckney
Hamburg
Whitmore Lake
Milan
Ypsilanti
Belleville
Wayne
Inkster
Ecorse
Grosse Ile
Gibraltar
Flat Rock
Carleton
Berlin
Ash
Milan
Raisinville
Summerfield
Petersburg
Palmyra
Riga
Wood
Lambertville
Sylvania
Toledo
Oregon
Curtice
Millbury
Graytown
Gibsonburg
Fremont
Clyde
Green Springs
Bellevue
Monroeville
Norwalk
Huron
Milan
Berlin Heights
Republic
Attica
Bascom
Melmore
Tiffin
Fostoria
Arcadia
Findlay
Ottawa
Kalida
Gilboa
Leipsic
Deshler
Belmore
Fostoria
Arcadia
Bascom
Tiffin
Carey
Upper Sandusky
Wharton
Nevada
Kirby
Crawford
Bucyrus
Galion
Mansfield
Shelby
Plymouth
Willard
Norwalk
Wakeman
Huron
Vermilion
Lorain
Elyria
Amherst
Oberlin
Wellington
Medina
Brunswick
Akron
Cleveland
Euclid
Painesville
Ashtabula
Conneaut
Geneva
Madison
Perry
Fairport
Mentor
Willoughby
Lake Erie
Detroit River
Sandusky Bay
Maumee Bay
Maumee R.
Huron R.
Clinton R.
Grand R.
Kalamazoo R.
Raisin R.
Portage R.
Auglaize R.
Tiffin R.
Sandusky R.
Cuyahoga R.
Rocky R.
Chagrin R.
Grand River Rapids & Indiana R.R.
Michigan Central R.R.
Michigan Southern R.R.
Lake Shore & Michigan Southern R.R.
Detroit & Milwaukee R.R.
Detroit & Cincinnati R.R.
Detroit & Toledo Shore Line R.R.
Detroit & Bay City R.R.
Flint & Pere Marquette R.R.
Toledo & Ohio Central R.R.
Toledo Peoria & Western R.R.
Toledo Delphos & Burlington R.R.
Toledo Cincinnati & St. Louis R.R.
Fort Wayne & Chicago R.R.
Wabash R.R.
Lake Shore & Michigan Southern R.R.
Cincinnati Hamilton & Dayton R.R.
Cincinnati Sandusky & Cleveland R.R.
Cleveland Columbus & Cincinnati R.R.
Cleveland & Pittsburgh R.R.
Pittsburgh Fort Wayne & Chicago R.R.
Lake Erie & Western R.R.
Louisville New Albany & Chicago R.R.
Indianapolis & Cincinnati R.R.
Indianapolis & Peru R.R.
Peru & Indianapolis R.R.
Chicago & Great Eastern R.R.
Chicago & Atlantic R.R.
Chicago & Grand Trunk R.R.
Detroit & Milwaukee R.R.
Michigan Air Line R.R.
Detroit & Milwaukee R.R.
Detroit & Pontiac R.R.
Detroit & Bay City R.R.
Flint & Pere Marquette R.R.
Toledo & Ohio Central R.R.
Toledo Peoria & Western R.R.
Toledo Delphos & Burlington R.R.
Toledo Cincinnati & St. Louis R.R.
Fort Wayne & Chicago R.R.
Wabash R.R.
Lake Shore & Michigan Southern R.R.
Cincinnati Hamilton & Dayton R.R.
Cincinnati Sandusky & Cleveland R.R.
Cleveland Columbus & Cincinnati R.R.
Cleveland & Pittsburgh R.R.
Pittsburgh Fort Wayne & Chicago R.R.
Lake Erie & Western R.R.
Louisville New Albany & Chicago R.R.
Indianapolis & Cincinnati R.R.
Indianapolis & Peru R.R.
Peru & Indianapolis R.R.
Chicago & Great Eastern R.R.
Chicago & Atlantic R.R.
Chicago & Grand Trunk R.R.


82
81
LONDON
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ESSEX
LAKE ERIE
LAKE ST CLAIR
PORT HURON
PORT SARNIA
Komoka
Strathroy
Mount Brydges
Longwood
St Thomas
Port Stanley
Harts
Union
Aylmer
Wyoming
Mandaumin
Wanstead
Waterford
Dutton
Capac
Memphis
St Clair
Belle River
Sydenham R.
Thamesville
Vosburgh
Chatham
Newbury
Bothwell
Thorndale
Ilderton
Lobo
Arva
Delaware
Dorchester
Melbourne
No. Westminster
So. Westminster
Yarmouth
Sarnia
Petrolia
Oil Springs
Detroit & Canada R.R.
Chicago & Canada Southern R.R.
Great Western R.R.
Grand Trunk R.R.
Lake Shore & Michigan Southern R.R.
Cleveland & Toledo R.R.
Cleveland & Mahoning R.R.
Cleveland & Pittsburgh R.R.
Cleveland & Erie R.R.
Cleveland & Columbus R.R.
Cincinnati & Indianapolis R.R.
Atlantic & Great Western R.R.
Cleveland
Euclid
Wickliffe
Willoughby
Mentor
Painesville
Madison
Perry
Geauga
Newburgh
Rockport
Berea
Bedford
Olmstead
Columbia
Macedonia
Aurora
Solon
Hudson
Portage
Ravenna
Rootstown
Akron
Medina
Wellington
Grafton
Brunswick
Richfield
La Grange
Millet Cr.
Cuyahoga Falls
Huron
Norwalk
Townsend
Wakeman
Kipton
Cooke's Cor.
Huron Junc.
Berlin
Milan
Vermilion
Sandusky
Germantown
Rochester
New London
Greenwich
New Haven
Plymouth
Shiloh
Steam Mill
Shelby
Mansfield
Ashland
Polk
Salem
Orrville
Wooster
Millbrook
Williamsfield
Jefferson
Ashtabula
Conneaut
Geneva
Alliance
Strasburg
Louisville
Canton
Massillon
Moultrie
Bayard
Minerva
Navarre
Lawrence
Seville
Medina
Wayne
Huron
Erie
Lorain
Cuyahoga
Portage
Summit
Stark
Carroll
Tuscarawas
Ohio
Crawford
Richland
Ashland
Wayne
Holmes
Coshocton
Knox
Licking
Muskingum
Perry
Morgan
Washington
Athens
Meigs
Gallia
Lawrence
Scioto
Pike
Jackson
Vinton
Hocking
Fairfield
Franklin
Pickaway
Ross
Pike
Scioto
Adams
Brown
Clermont
Hamilton
Butler
Warren
Clinton
Fayette
Madison
Champaign
Clark
Greene
Montgomery
Preble
Darke
Miami
Shelby
Auglaize
Mercer
Van Wert
Paulding
Defiance
Williams
Fulton
Henry
Lucas
Wood
Ottawa
Sandusky
Seneca
Hancock
Putnam
Allen
Wyandot
Marion
Morrow
Delaware
Union
Logan
Champaign
Clark
Greene
Montgomery
Preble
Darke
Miami
Shelby
Auglaize
Mercer
Van Wert
Paulding
Defiance
Williams
Fulton
Henry
Lucas
Wood
Ottawa
Sandusky
Seneca
Hancock
Putnam
Allen
Wyandot
Marion
Morrow
Delaware
Union
Logan


81
43
42
41
CANADA
HALDIMAND
NORFOLK
ERIE
LAKE ERIE
Simcoe
Dunnville
Cayuga
Middleport
Cookstown
Camelia
Grand R.
Benton
Aylmer
Sarnia
Harts
Union
RT STANLEY
No. Westminster
So. Westminster
Yarmouth
Arkona
Bothwell
Wardsville
Ridgetown
Chatham
Tilbury
Wallaceburg
Dresden
Thamesville
Delaware
Strathroy
Mt. Brydges
Glencoe
Newbury
Wardsville
Ekfrid
Melbourne
Parkhill
Komoka
Ilderton
Lobo
Delaware
Arva
Byron
London
Westminster
Dorchester
Thorndale
Lucan
Crumlin
Nissouri
Embro
Woodstock
Beachville
Ingersoll
Tavistock
Hickson
Norwich
Otterville
Springfield
Vienna
Port Burwell
Port Stanley
Aylmer
Sparta
Malahide
Port Bruce
Port Talbot
Dunboyne
Shedden
Rodney
Belmont
Dutton
Wallacetown
Port Glasgow
Ripley
Quincy
State Line
North East
Moreheads
Harbor Creek
Wesleyville
Panama
Clymer
Waterford
Langdon
Jacksons
LeBoeuf
Union Mills
Belle Valley
Crosse
Albion
Mill Village
Millers
Cambridge
Lincoln
Spartansburg
Centre
Hydetown
Tryonville
Meadville
Junction
Shaws Landing
Sullivans Cor.
Petroleum C.
Coopers T.
Ronse V.
Evansburg
Cochranton
Adamsville
Sugar Grove
Utica
Brown V.
Sugar Cr.
Reno
Franklin
Cochran
E. Sandy
Brandons Cy.
Roberts R.
Rockland
Emlenton
Scrubgrass
Harrisville
Bradys Bend
Phillipsburg
Spring Cor.
Conneaut V.
Summit
Saegertown
Kingsville
Ashtabula
Geneva
Jefferson
Dorset
Madison
Painesville
Richmond
Gimesville
Morgan
Espyville
Andover
Orwell
Williamsfield
Chardon
Burton
Jamestown
Gustavus
Greenville
Johnsons Sum.
Orangeville
Parkman
Bacons Corners
Windham
Garrettsville
Hiram
Mantua
Shalersville
Ravenna
Warren
Mercer
Wheatland
Niles
Newton Falls
Middleport
Hubbard
Youngstown
Struthers
Canfield
Atwater
Lima
Alliance
Strasburg
Homeworth
Georgetown
Chester
Moultrie
Bayard
Minerva
Columbiana
Lisbon
Franklin
Hanover
Elkton
Smith
Rochester
Freedom
Beaver
New Brighton
Homewood
Darlington
Enon
N. Galilee
Clinton
Newport
Mahoning
Moravia
Pulaski
Harbor Br.
New Castle
Mahoning
Lawrence
Butler
Brinkers
Delano
Harvey
Freeport
Ashtabula
Trumbull
Portage
Mahoning
Columbiana
Meadville
Crawford
Venango
Butler
Beaver
Erie
Lake Erie
Cleveland & Erie R.
Erie & Pittsburg R.R.
Great Western R.R.
Loop Line Great Western R.R.
Canada Southern R.R.
Lake Shore R.R.
Franklin Br.
Allegheny R.
Oil Creek
Conneaut
Springfield
Girard
Fairview
Swanville
Harborcreek
Union
Sunbury
Erie
Lincoln
Columbus
Ashtabula
Trumbull
Portage
Mahoning
Columbiana
Meadville
Crawford
Venango
Butler
Beaver
Erie
Lake Erie


OHIO
PREPARED BY G.W.& C.B.COLTON & Co 172 WILLIAM St NEW YORK
LONGITUDE WEST FROM WASHINTON
7
6
ADAMS
WELLS
MERCER
AUGLAIZE
HARDIN
MARION
MORROW
KNOX
BLACK
FORD
DELAWARE
RANDOLPH
DARKE
SHELBY
LOGAN
CHAMPAIGN
MADISON
FRANKLIN
PICKAWAY
FAYETTE
CLINTON
WARREN
GREEN
MONTGOMERY
PREBLE
BUTLER
HAMILTON
CLERMONT
BROWN
ADAMS
PIKE
SCIOTO
JACKSON
GALLIA
MEIGS
ATHENS
HOCKING
PERRY
MORGAN
WASHINGTON
NOBLE
WAYNE
HENRY
RUSH
FAYETTE
UNION
FRANKLIN
DEARBORN
RILEY
OHIO
SWITZERLAND
JEFFERSON
MADISON
DECATUR
HANCOCK
HARRISON
CRAWFORD
KENTUCKY
Bluffton
Monroe
Warren
Lima
Sugar Creek
Cloud Side Track
Gravel Bank
Kenton
Caledonia
Iberia
Silver Creek
Yelverton
Ridgeway
Big Spring
Rushsylvania
Harper
Huntsville
Richland
Bellefontaine
Ashley
Eden
Berlin
South Switch
Galena
Lewis Center
Orange
Johnstown
Westerville
Worthington
Columbus
Grove City
Edwards
Winchester
Waterloo
Lockbourne
Harrisburg
Florence
Charleston
Selma
Cedarville
Pierce
Xenia
Flamestown
Palestine
Darbyville
Bloomingburg
Jasper Mills
Kingston
Anderson's
Chillicothe
Schooleys
Londonderry
Bainbridge
Cincinnati
Cynthiana
Waverly
Piketon
Scioto Furnace
Scioto
Portsmouth
Rome
Rockville
Concord
Vancebur
Manchester
Aberdeen
Ripley
Lavanna
Russellv.
Higginsport
Georgetown
Carlisle
Fincastle
Taylor V.
Williamsburg
Batavia
Palestine
New Richmond
Pt Pleasant
Chilo
Neville
Mos-cow
Behmont
Cincinnati
Covington
Culbertson
Ryland
Canton
Benton
Mullins
Demossville
Meridian
Boston
Irving
Marshall
Falmouth
Livingood
Morgan
Boyd
Carter
Johnson
Garfield
Cynthiana
Milford
Loveland
Morrow
Lebanon
Ogden
Wilmington
Clarksville
Sabina
Corwin
Freeport
Xenia
Springfield
Dayton
Troy
Piqua
Sidney
Greenville
Eaton
Richmond
New Castle
Knightstown
Carthage
Falmouth
Connersville
Rushville
Greensburg
Batesville
Aurora
Lawrenceburg
Versailles
Osgood
Moorefield
Rising Sun
Bellevue
Hamilton
Patriot
Florence
North Madison
Vevay
Milton
Ghent
Carrollton
Warsaw
New York
Zion
Verona
Elliston
Glencoe
Sparta
Liberty
Eagle
Turners
Bethlehem
La Grange
Jericho
Sulphur
Campbellsburg
Westport
Eminence
Bellevue
Louisville
Hillsboro
Greenfield
Washington
Chillicothe
Cincinnati
Wilmington
Xenia
Springfield
Dayton
Troy
Piqua
Sidney
Bellefontaine
Marion
Delaware
Mansfield
Zanesville
Cambridge
Marietta
Athens
Logan
Lancaster
Newark
Granville
Mount Vernon
Wooster
Orrville
Akron
Cleveland
Toledo
Findlay
Fostoria
Tiffin
Bucyrus
Galion
Crestline
Upper Sandusky
Kenton
Findlay
Defiance
Napoleon
Bryan
Wauseon
Archbold
Fayette
Stryker
Montpelier
Edgerton
Hicksville
Antwerp
Paulding
Van Wert
Celina
Coldwater
Minster
New Bremen
Botkins
Fort Recovery
Versailles
Greenville
Union City
Winchester
Muncie
Anderson
Alexandria
Elwood
Kokomo
Peru
Logansport
Rochester
Plymouth
Knox
Winamac
Monticello
Lafayette
Crawfordsville
Rockville
Terre Haute
Brazil
Clinton
Paris
Danville
Hoopeston
Watseka
Momence
Kankakee
Chicago
Gary
Hammond
Whiting
Michigan City
La Porte
Valparaiso
Hobart
Crown Point
Lowell
Rensselaer
Kentland
Goodland
Morocco
Kniman
Medaryville
Francesville
Winamac
Monterey
Culver
Plymouth
Bremen
Nappanee
Goshen
Elkhart
South Bend
Mishawaka
Niles
Buchanan
Dowagiac
Cassopolis
Edwardsburg
Constantine
Three Rivers
Centreville
White Pigeon
Sturgis
Coldwater
Bronson
Quincy
Hillsdale
Jonesville
Litchfield
Allen
Somerset
Jerome
Tecumseh
Adrian
Blissfield
Deerfield
Clayton
Morenci
Wauseon
Pioneer
Bryan
Edgerton
Montpelier
Stryker
Archbold
Fayette
Delta
Wauseon
Swanton
Toledo
Maumee
Perrysburg
Bowling Green
Fremont
Clyde
Gibsonburg
Woodville
Elmore
Oak Harbor
Port Clinton
Sandusky
Huron
Vermilion
Lorain
Elyria
Oberlin
Wellington
Norwalk
Milan
Berlin Heights
Monroeville
Plymouth
Shelby
Mansfield
Ashland
Loudonville
Millersburg
Wooster
Orrville
Smithville
Canal Fulton
Massillon
Canton
Alliance
Salem
East Liverpool
Wellsville
Steubenville
Cadiz
Carrollton
Minerva
Malvern
Sandyville
Dover
New Philadelphia
Uhrichsville
Dennison
Coshocton
Roscoe
Port Washington
Newcomerstown
Cambridge
Byesville
Cumberland
Senecaville
Caldwell
Woodsfield
Barnesville
Flushing
St Clairsville
Martins Ferry
Bellaire
Wheeling
Moundsville
Glen Easton
Triadelphia
Bethany
Wellsburg
Follansbee
Weirton
Steubenville
Toronto
Yellow Springs
Xenia
Jamestown
Cedarville
Spring Valley
Waynesville
Lebanon
Mason
Deerfield
Loveland
Milford
Batavia
Amelia
Bethel
Felicity
Moscow
Neville
Point Pleasant
Ripley
Aberdeen
Manchester
Portsmouth
Rockville
Concord
Vancebur
Lavanna
Russellv.
Higginsport
Georgetown
Carlisle
Fincastle
Taylor V.
Williamsburg
Batavia
Palestine
New Richmond
Pt Pleasant
Chilo
Neville
Mos-cow
Behmont
Cincinnati
Covington
Culbertson
Ryland
Canton
Benton
Mullins
Demossville
Meridian
Boston
Irving
Marshall
Falmouth
Livingood
Morgan
Boyd
Carter
Johnson
Garfield
Cynthiana


Mansfield
Millbrook
Massillon
Navarre
Bayard
Waynesburg
Malvern
Lexington
Perry
Pleasant City
Londonville
Belleville
Independence
Gilead
McGilead
Millersburg
Berlin
Dover
NEW PHILADELPHIA
CARROLLTON
Ankneytown
Maple Grove
Fredericktown
Kinderhook
Balls Crossing
Port Washington
TUSCARAWAS
Ashley
Eden
Wallace's Mill
New Comerstown
Keene
COSHOCTON
Martinsburg
Utica
HARRIS
South Switch
Berlin
Galena
Lewis Center
Orange
Johnstown
Westerville
Worthington
Louisville
Vanatta
Adams V.
GUERNSEY
Washington
CENTRAL OHIO R.R.
Fairview
Flushing
St. Clairsville
Dillons Falls
W. Zanesville
Del Carbo
Somerset
Sarahsville
NOBLE
Caldwell
Dudley
Woodsfield
COLUMBUS
Edwards
Winchester
Waterloo
Baltimore
Lithopolis
Hugh
FAIRFIELD
Hookers
PERRY
McConnellsville
MORGAN
Beverly
Salem
Whipple
Cockran
Sugar Gr.
Amanda
Mill Enterprise
New Straits V.
Logan
Chesterfield
Caywood
Wesley
Newport
St. Marys
Bayden
Bessemer
Wilsonville
Murray City
Woodwood
Kingston
HOCKING
ATHENS
Salina
Constitution
Andersons
Chillicothe
Schooleys
Mt. Arthurs
Zaleski
Coal Mines
Hope Furn.
Monroeville
Mineral City
Cutler
Little Hocking
Vincents
Belpre
PARKERSBURG
VINTON
London Ferry
Rayesville
Vinton Furnace
Hocking
Cincinnati Furn.
Mt. Arthur
Hamden
Belle V.
Waverly
Elys Mines
Chester
Shade R.
Murrays
MEIGS
Berlin
Perea
Wilkesville
Pomeroy
Coalport
Pikeon
Jackson
Keystone Fur.
Irwins Sta.
Vaughn
Middleport
Cheshire
Grahams Sta.
Ripley
Portland
Bloom Furnace
Gallipolis
Point Pleasant
GALLIA
Scioto Furnace
Gephart's
Cooper
Scottsville
Cenery Sta.
Wheelersb.
Lawrence Fur.
Pine Grove
Vesuvius Sta.
La Grange Fur.
Millersport
Riverton
IRONTON
Hanging Rock
Argillite
ASHLAND
Bellefont
Clinton
Proctors V.
Guyandotte
HUNTINGTON
Canonsburg
Burlington
Cerredo
CATLETTSBURG
Buena Vista
COAL FIE
to the M
The colored line shows the western limit of the Coal Formation in Ohio.
SCALE 20 MILES TO AN INCH
0 5 10 20 30 40
Railroads completed
Railroads in progress

GRAIL ROAD MAP

Showing the relation of the

COAL FIELD of SOUTH EASTERN OHIO

to the Markets of the North and West

to accompany a Report by

T. STERRY HUNT LL.D. F.R.S.

1874.

western limit
Ohio.
AN INCH
30 40
mpleted
progress

THE COAL AND IRON OF SOUTHERN OHIO

CONSIDERED WITH RELATION TO

THE HOCKING VALLEY COAL FIELD

AND

ITS IRON ORES,

WITH NOTICES OF

FURNACE COALS AND IRON SMELTING,

FOLLOWED BY A VIEW OF

THE COAL TRADE OF THE WEST.

BY

T. STERRY HUNT, LL.D., F.R.S.

SALEM, MASS.
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PREFACE.

In preparing the following sketch of a portion of the coal and iron region of southern Ohio, I have brought together the principal facts with regard to it from all available sources. These have been in the first place the detailed observations of Professor E. B. Andrews, charged with the survey of this part of Ohio, which will be found in the official reports of the geological survey of the state published in 1869 and 1870. The first volume of the final report entitled "The Geology of Ohio," which appeared in 1873, contains, of the region here included, an account only of Athens county. The later observations of Professor Andrews in the other counties of the region are as yet unpublished, with the exception of some which are to be found in a private report by him on certain coal lands in Perry county. From the last mentioned volume and from this report, as also from a private report and a printed section by Mr. M. C. Read of the geological survey, and another report by Mr. Isaac B. Riley, C. E., of Newark, Ohio, all upon this coal region and all published in 1873, I have gathered a large additional amount of valuable material.

For the general account of the coal measures of Ohio in the Introduction, I am largely indebted to the descriptions of Dr. J. S. Newberry of New York, the director of the geological survey of Ohio, which will be found in the above mentioned volumes. Dr. Newberry has also kindly furnished me yet unpublished notes, made by his assistant, Mr. Henry Newton, M. E., of New York, and has otherwise aided me. Valuable information has been derived from several small pamphlets on this coal region by Col. Charles Whittlesey of Cleveland, Ohio, who in addition to these has furnished me with private information. The chemical analyses of the coals and the iron ores are, with few exceptions, taken from the elaborate and valuable report of Prof. T. G. Wormley, of Columbus, chemist to the geological survey, which appeared in the volume for 1870. To these are added some more recent analyses taken from that for 1873,

and still more recently of materials collected by myself and analyzed by Dr. Drown of Philadelphia, and Mr. Stafford of the Massachusetts Institute of Technology.

To the above sources of information I must add the results of my own observations made during two short visits to portions of this region within the last six months, by which I have been enabled to extend considerably our knowledge of the distribution of the coal, and the nature and distribution of the iron ores. For valuable information relating to the manufacture of iron, I have to thank Mr. T. S. Blair of Pittsburgh, Mr. W. A. Hooker of Cleveland, Mr. S. Baird of Columbus and Mr. Harvey Wells and Mr. Cobb of Milton. My personal acknowledgments are also due to several gentlemen at Columbus and Newark and in various parts of the coal region for kind attentions and courtesies.

For the statistics of the coal trade I am much indebted to a recent valuable little work by Mr. Fred. E. Saward of New York entitled, "The Coal Trade," and also to notes, both printed and in manuscript, furnished by Mr. E. D. Mansfield of Cincinnati. The information about the railway system of the region has been gathered in part during my visits to these regions, but chiefly from the recent reports of Messrs. Riley and Andrews, noticed above. In a compilation like the present it is not easy to avoid falling into some errors, for which, in advance, I ask indulgence, feeling that I have done my best to avoid them.

Two maps accompany this publication, one a general railway map, showing the relation of the coal region of Ohio to the markets of the north and west; the other a map of some of the southern counties in the coal region, on a scale of two miles to an inch, compiled for the occasion by Mr. Isaac B. Riley, C. E., drawn by Mr. D. W. Curtin and engraved by G. W. & C. B. Colton & Co. of New York.

T. S. H.

INSTITUTE OF TECHNOLOGY,
Boston, Mass., May 1, 1874.

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ON THE

COAL AND IRON REGION

OF

SOUTHERN OHIO.

INTRODUCTION.

§ 1. The coal-bearing rocks of eastern Ohio constitute the northwest portion of the great Appalachian or Alleghany coal-basin, to which also the coals of Pennsylvania belong, and which extends in its southern prolongation through West Virginia and the eastern parts of Kentucky and Tennessee into northern Alabama. Along the eastern border of this great area of bituminous coal are the small detached basins yielding semi-bituminous coal, and known as the Cumberland of Maryland, the Broad Top, and farther to the northeast those of Snowshoe, Phillipsburg, Ralston, Towanda and Blossburg of Pennsylvania; while still farther in the same direction are the anthracite fields. All of these doubtless once formed parts of the great Appalachian area, though since separated from it by geological changes.

§ 2. The length of this vast basin of bituminous coal from northeast to southwest is 875 miles, and its maximum

breadth across Pennsylvania and Ohio about 180 miles, while its total area is estimated at about 58,000 square miles, of which about 10,000 square miles are included in the state of Ohio. The western limit of the coal formation in this state is defined by a line beginning on the Pennsylvania boundary in Trumbull county and extending westward, with an irregular course, through Portage, Summit and the southwest part of Medina county, thence turning southward through the east part of Wayne and the west part of Holmes and Coshocton counties, along the eastern limits of Licking and Fairfield, and through Hocking, Vinton, Jackson and Scioto counties to the Ohio River near the mouth of the Scioto.

§ 3. The strata of the great Appalachian coal basin are divided, in accordance with the classification long since adopted by the geological survey of Pennsylvania, into a Lower and an Upper Coal Series. This latter division, which occupies but a comparatively small area in Ohio, includes at its base the great Pittsburgh seam, which crosses the Ohio River a little north of Steubenville, and, according to H. D. Rogers, pursues a general southwest course to McConnelsville on the Muskingum River, thence more southward, passing a little east of the town of Athens, through Meigs and Gallia counties towards the Ohio River, which it reaches again a short distance above Burlington in Lawrence county. The whole of the coal basin in Ohio, to the north and west of the line thus traced, belongs to the Lower Coal series. This generally rests upon a considerable thickness of conglomerate (which is however in some cases wanting), and was in Pennsylvania divided into the Productive Measures, which are below, and the Barren Measures, which are above; a similar twofold division being also recognized in the Upper Coal series.

§ 4. The productive measures of the Lower Coal series, including several important coal seams, are overlaid by

the so-called Mahoning sandstone, followed by a series of strata, which, though they have been found to contain in some parts of their distribution workable seams of coal, still retain their name of the barren measures. The thickness of the productive measures to the base of the Mahoning sandstone in Holmes county, Ohio, is about 300 feet, and in northwestern Pennsylvania about 400 feet, while the overlying barren measures are there somewhat greater in amount. The whole series of the Lower Coal measures, including these two divisions, is, however, subject to considerable variations from the local thickening or thinning of individual members, and their occasional absence, but in southern Ohio will not probably be far from 700 feet.

§ 5. The various coal seams found in the Lower Coal series (including the so-called barren measures), as deduced by Dr. Newberry from his studies in northern Ohio, are given below in descending order. The letters and names by which the principal seams were originally designated in the Pennsylvania survey being in brackets.

The Coal No. 8 [H. Pittsburgh], with its underlying fire-clay, belongs to the UPPER COAL SERIES, but rests directly upon the *Barren Measures* of the LOWER COAL SERIES. These, consisting of sandstones and shales, with two small limestone formations in the upper part, include

Coal 7b. — [G.]	½—4	feet.
Coal 7a. — [F.]	1—6	"
Coal 7 —	0—5	"

Beneath this last lies another limestone bed, followed by the Mahoning sandstone, which is in some localities from forty to sixty feet in thickness, and in others is in part replaced by shales. Below it are the *Productive Measures* including

Coal 6 — [E. Upper Freeport] . . .	4—7	feet.
Coal 5 — [D. Lower Freeport] . . .	2—4	"
Coal 4 — [C. Kittanning]	2—6	"
Coal 3a. — local	2—3	"
Coal 3 — [B.]	2—4	"
Coal 2 — generally thin	1—6	"
Coal 1 — [A. Briar Hill or Block Coal]	3—4	"

§ 6. The intervals between these different coals, as seen in the northeastern part of Ohio, vary greatly in different localities. Thus between Coals 7 and 6, the interposed strata measure from fifty to one hundred feet, and those between 6 and 5 (where both of these are present) from twenty to sixty feet; while along the western margin, (where 5 is generally absent) the interval between 6 and 4, which equals 100 feet farther eastward, is reduced to twenty-five feet. Between 4 and 3 the interval varies from twenty to eighty feet; 3a (and sometimes another thin seam not indicated in the above list,) intervenes where the distance is greatest. The interval between 3 and 2 is more constant, being from eighty to ninety feet, while that between 2 and 1 is extremely irregular, sometimes varying fifty feet within a few hundred yards; this variation being mainly due to waves or undulations in the lower seam, which generally reposes upon a conglomerate, sometimes with the intervention of a variable amount of shale. This conglomerate, in some places one hundred feet or more in thickness, is in other cases almost or altogether wanting, and the coal measures then repose directly upon the Waverley sandstone of the Lower Carboniferous.

§ 7. It will be seen from the above account that the Lower Coal series in northern Ohio offers considerable variations not only in the thickness of the coal seams and of the intervening strata, but also in the occasional absence of some of the members, and, it may be added, in the quality of the same seam of coal in different parts of its distribution. These various irregularities are equally noticeable in other parts of the great Appalachian basin, and, as long since remarked by Lesley, are much more marked in the Lower than in the Upper Coal series.

§ 8. When we come to study the Lower Coal measures in the southern part of Ohio we find that there have been some differences of opinion as to the precise equivalence

of the individual beds with those in the north. It is not easy to prove that the lowest coal seam of Jackson county is a continuation of the lowest seam of Mahoning county, yet if we reckon downward from the Pittsburgh seam there appears such a general correspondence as leads us to conclude that the lower measures of the two regions are, if not identical, very similar.

§ 9. The characteristic seam of the Lower Coal series in the southern region is the Nelsonville or Straitsville seam, which lies, according to Prof. Andrews, about 420 feet below the Pittsburgh or Pomeroy seam, and is, with great reason, regarded by Newberry as Coal 6 of his series, the equivalent of the Upper Freeport of Pennsylvania. This coal is, to the southwest, in Jackson and Vinton counties, overlaid by an ore-bearing limestone, and is there known as the Limestone coal. Beneath this there are several workable coal seams; near the town of Jackson in Lick township are found, according to Prof. Andrews, not less than three seams of dry-burning coal from three to four feet in thickness, above which is a seam of cannel. A cannel coal, probably the same, appears in several sections in this region about seventy-five feet below the Limestone coal. According to data furnished me by Mr. H. Wells, there are in Milton township within a vertical distance of 275 feet beneath the last named coal, four and probably five coal seams, one of which lies about twenty-five feet below the Limestone coal. Beneath this is the cannel, which is from one and a half to four feet in thickness, which has been mined to some extent as a gas-coal, while the lowest seam, now mined at Wellston in Milton, is a dry-burning coal from four to nearly five feet in thickness. It is supposed to be the same with the lower or shaft-coal mined at Jackson, and both are used with great success as furnace-coals, as is also a higher seam from two and a half to three and a half feet thick mined at Jackson and known as the hill-coal.

§ 10. The Nelsonville coal, as we go northeast into Vinton, Hocking, Athens and Perry counties, is no longer overlaid by the limestone band to which it owes its name to the southward, but assumes a greater importance, and from a thickness of four feet rises to six and seven, and finally in parts of Perry county attains eleven and even thirteen feet. From its superior quality and its great development it becomes the most important coal seam in Ohio. Throughout this region it is known as the Nelsonville or Straitsville seam or the Great Vein, but farther northward, where it becomes thinner, as the Upper New Lexington coal.

§ 11. At a distance of from forty to fifty feet above the great vein there is found in some parts of this region another seam of coal which generally attains a thickness of four feet or more, and is described by Prof. Andrews as the Norris or Middle seam, from the fact that it is intermediate between the Nelsonville and a still higher one known as the Bayley's Run or Stallsmith coal, which lies from eighty to one hundred feet above the Nelsonville, and is a highly bituminous coking coal, attaining a thickness of four and five feet. In some parts of this region there are apparently irregularities in the strata immediately above the great vein, the intervals between the coals varying; while occasionally the middle seam appears to be absent. This latter may be provisionally designated as Coal 6a, while the upper seam is regarded as Coal 7.

§ 12. It is not easy in this region to fix upon the representative of the Mahoning sandstone of the north, or to say whether one or both of the seams just named belong to the so-called barren measures. They are however succeeded by a considerable thickness of strata nearly destitute of coal, which are well seen along the line of the Marietta and Cincinnati railroad to the east of Athens station. These include two considerable deposits of limestone, the first of which, according to Andrews, is two hundred feet above

the Nelsonville coal, and the second eighty feet above the last; while one hundred and forty feet higher, or four hundred and twenty feet above the Nelsonville seam, we find the Federal Creek or Pomeroy coal, which is the Pittsburgh seam, already mentioned as forming the base of the Upper Coal series. This seam attains a remarkable development in some of the tributaries of Federal Creek in Berne and Rome in Athens county, not far from Big Run station on the M. & C. railroad, exhibiting in some parts not less than nine feet of coking coal of superior quality. Above this seam are several others of less importance which need not now occupy our attention.

§ 13. Small formations of limestone are found at several horizons interstratified with the sandstones and shales of the coal measures above described, but are often local and interrupted. They are frequently associated with a flinty quartz or chert, which in some localities yields excellent millstones. This material, known as buhrstone, was formerly supposed to be confined to the vicinity of a single limestone band which, to the northward, overlies Coal 3, and this, according to Newberry, led to some mistakes in the identification of coal seams. There are in reality layers of buhrstone with limestone at several horizons in the coal measures.

§ 14. The iron ores which are interstratified with the coal measures in Ohio are of great importance, and are smelted extensively in various parts of the state. These ores, which are found at several horizons in both the lower and upper series, are most frequently carbonates, sometimes in sheets, and at other times nodular, while they occasionally assume the form of black-band. At and near their outcrops these carbonated ores are frequently changed into limonites. More rarely a compact red hematite, very hard and dense, is met with. In the northern part of the state a stratum of ore is found beneath the lowest coal; this is sometimes a black-band ore, as in Mahoning county, where it has long been smelted. Passing

over several layers of ore above this, we note in the north a band of nodular ore just above Coal 5 (which possibly corresponds to a layer of kidney ore below the great vein in the south) and a still higher layer which occurs immediately over Coal 7, and is in parts of Tuscarawas and Stark counties, a black-band from sixteen to twenty feet in thickness; while elsewhere it is wholly or in part a nodular carbonate ore, and is sometimes associated with a limestone, often itself ferruginous.

§ 15. It is however in the southern counties that these ores are best known, where, in the Hanging Rock region, they have long been mined and smelted on a great scale. Beneath the Limestone coal are several layers of ore of considerable importance, including, in Jackson county, two or more of the so-called block ores; while in Milton, about thirty feet above what is considered the lowest coal, is a layer of nodular red hematite of great hardness and density, said by Mr. Wells to be about twenty inches in thickness. From twenty-five to thirty feet below the Limestone coal is a layer of kidney or nodular carbonate ore varying from six inches to more than a foot in thickness, while immediately above the limestone which overlies the coal just named, the equivalent of the great vein, is the so-called limestone-ore, the most important deposit in the region, which varies from a few inches to three feet, and even six feet in thickness.

§ 16. As we go northeastward this limestone, as already said, is no longer found above the great vein or Nelsonville seam, and the accompanying ore is also absent. In the valley of the Hocking River, and to the northward, the layer of kidney ore, frequently a foot or more in thickness, is found beneath the great seam, sometimes at a distance of ten or twelve feet, but elsewhere separated from the coal only by two or three feet of fire-clay. Another and an important band of ore, associated with a thin layer of limestone, lies a little above the Norris or middle seam, and

sometimes attains a thickness, according to Mr. Read of the geological survey, of four and a half feet. Little attention has been paid to the iron ores in these higher portions of the coal measures, since the existing furnaces have hitherto got their supplies from the lower layers already noticed. According to the statements of the Rev. J. P. Wethee, cited by Prof. Andrews, there are in Dover and Trimble townships and their vicinity, between the Bayley's Run and Federal Creek or Pomeroy coal seams, not less than seven workable layers of iron ore, the most, if not all of which, are equal in thickness and in richness to the great limestone ore stratum of the southern counties. These various ores will be noticed farther on.

§ 17. The sandstones which lie beneath the coal measures in southern Ohio, afford in many parts petroleum, and abound in brines, which are obtained by boring, and are used for the manufacture of salt. At Pomeroy, where the wells are sunk through the whole of the Lower Coal ies, the brine is reached at a depth of about 1000 feet, but to the northwestward and in the Hocking valley it is found at 700 feet. The seat of these brines is in the Lower Carboniferous rocks, known in Ohio as the Waverley and Logan sandstones. According to Prof. Andrews, however, good brines are, in Noble and Washington counties, obtained from the higher sandstones interstratified with the coal measures, and consequently at a less depth. The value of the salt made in Ohio, in 1870, was estimated at a little over three-quarters of a million of dollars, of which two-thirds was produced in Meigs county. There are however salt-wells in Guernsey, Muskingum, Tuscarawas, Morgan, Perry and Athens counties.

§ 18. The strata of the coal formation in eastern Ohio are very slightly inclined, and are usually described as having a uniform dip to the south of east. It has, however, been shown by Newberry that they form several troughs with a general northeast and southwest direction, the strata

on the eastern side of these having a slight dip to the northwestward. By these gentle undulations the beds are kept near the surface, so that the section on the east line of Columbiana county is the same with that 100 miles farther eastward near Pittsburgh, Pennsylvania; the average dip across this region not exceeding three feet in a mile. Farther to the southwest the inclination of the strata is greater, but rarely, according to Andrews, exceeds thirty feet to the mile, its direction being stated at from 10° to 20° south of east. These slight undulations of the strata are seldom or never accompanied by faults, and are the feeble representatives of the great flexures which have so much disturbed the eastern part of the coal basin.

§ 19. Having thus given a general notion of the Lower Coal measures of Ohio, we shall now proceed to a more detailed description of Coal No. 6, being the Nelsonville or Straitsville seam, locally known as the great vein, which from its thickness, position and valuable qualities is the most important coal in the state. Its distribution, its variations in thickness, its character and uses will be described, to be followed by a similar description of Coals 5, 6a and 7. An account of the nature, character and uses of all of these coals will then be given, with numerous analyses by Prof. T. G. Wormley, the chemist of the Ohio geological survey. These will be followed by observations on the value of the coal of the great vein for iron-making, as a furnace-coal, in which connection some facts will be given with regard to the native iron ores, their extent, their importance and the cost of mining and smelting them, the importation of foreign ores, and the future of the iron-industry in Ohio, to be followed with some details with regard to the other furnace-coals. To this will be added considerations on the commercial importance of the coals of the Hocking Valley in relation to the markets of the north and west, with statistics of the coal trade of these regions.

THE HOCKING VALLEY COAL FIELD.

§ 20. The seam of coal which we have referred to No. 6 of Dr. Newberry's series, or the Upper Freeport of Pennsylvania, is, as we have seer, known in some parts of southern Ohio as the Limestone coal, from the layer of limestone (bearing iron ore) which there rests upon it. The limestone is found in this position in Jackson county, and as far northward as Elk and Madison in Vinton county, beyond which it is not known. The underlying coal in the townships just named, and in Milton, Jackson county, is from 3′ to 4′ in thickness, and is described as a good dry-burning coal, which is mined in some localities. Towards the Ohio River it becomes thinner, and in some places only a trace of the seam is found, but in Kentucky it again becomes of some importance.

§ 21. Passing northwards we leave the overlying limestone in Elk and Madison, when the coal becomes thicker, and is known as the great vein. On the Marietta and Cincinnati railroad, a little west of Hope station, this seam is exposed in the valley of Raccoon Creek, in section 19 of Brown township, but its thickness there cannot be determined. About four miles to the northward, after passing over the hills, the great vein is exposed in section 29 of the same township, in the valley of Two-Mile Run, where I found exposed a thickness of 6′ 8″, with two thin clay partings. About three miles to the northeast of this, it again appears in section 7 of the township of Starr, Hocking county, on the land of Mr. Simms, where the coal is mined for local use, and measures 6′ 6″. Both in Starr and in Brown it was seen to be underlaid at a depth of about twenty-five feet by a seam of coal, and overlaid by two others, all of which will be noticed in their place.

§ 22. To the eastward of Brown, lie the townships of

Waterloo and Athens in Athens county. These, there is every reason to believe, are underlaid by the great vein, which dips with the strata to the south of east, at a slight angle. A boring made last winter in section 32 of Waterloo, not far from the western border of the township, and a few rods north of the Marietta and Cincinnati Railroad, showed, according to the record furnished me by J. M. Welch, Esq., of Athens, at a distance of seventy feet below the valley, a seam of coal probably not less than 6′ thick. It had been penetrated some inches before the coal was detected, after which 5′ 4″ were passed through. Farther to the northeast it is reported to have been found in former borings for oil, in section 16 of Waterloo, at a depth of seventy-six feet, and in section 4 at one hundred and eight feet, with a thickness of 6′.

§ 23. In Athens township, and near the town of that name, the coal of the great vein was reached some years ago by a shaft at a depth of two hundred feet, but the seam was found to be irregular, though in parts 5′ 6″, and the working was abandoned. Prof. Andrews suggests that it may be only a local irregularity since, in a boring for salt, three miles to the west, the coal was found at one hundred and forty feet, and also in another boring two miles to the north, in both with a thickness of 6′. Nothing is known of it in the eastern part of the township of Athens.

§ 24. Taking the townships in successive ranges from west to east, we have to the north of Brown, Waterloo and Athens, the townships of Starr in Hocking county, and York and Dover in Athens county. A large part of Brown, Starr and York, consists of bold, elevated land, belonging to what are known as the Hocking Hills, and it is only in the valleys that the great vein of coal is exposed. We have already, in § 21, noticed its occurrence in the southeastern part of Starr, in section 7, with a thickness of 6′ 6″, and it is said in the vicinity to have a thickness of 7′. It is

not known how far to the westward in Starr this vein may extend, but the strata in the western part of the township appear to belong to a lower horizon.

§ 25. Passing eastward into York, in the northern part of which, in section 24, is situated Nelsonville, we find the great vein largely mined at various points along the line of the Columbus and Hocking Valley railroad, which follows the valley of the Hocking River, along both sides of which the coal is exposed, nearly to the southeastern corner of the township, where the vein sinks beneath the water-level. At Lick Run mine in fraction 18, and at Brooks's mine in section 29, the coal has a thickness of 6′ 6″ and 6′ 5″, with two clay partings, and yields six feet of clean coal, which is the general yield of the workings along the river valley in this vicinity. In the valley of Spring Branch, in section 32 of York, I found the seam exposed with a thickness of 6′ 6″, and again about two and a half miles to the northeast it appears in the valley of Meeker's Run, with a thickness of 9′, including a foot of shale near the upper part. Near Bessemer, in section 12, of York, the seam is described by Mr. M. C. Read as having a thickness of 9′ 7″, including three clay partings with an aggregate thickness of 13″, instead of two, as generally seen.

§ 26. We find, in fact, at Nelsonville, Lick Run and elsewhere in this vicinity, that the shale which forms the roof of the seam often carries above it a layer of coal, which is sometimes very thin and at other times measures a foot or more. The shale parting which divides this from the body of the vein, may also be thin, as at Bessemer, or of considerable thickness. In the hill behind Nelsonville, according to Andrews, there is found a layer of from 6″ to 24″ of coal, separated from the mass of the great vein by 3′ 9″ of shale. This upper coal, when present, is always left behind in mining, as being of inferior quality. The six feet of good coal in this vicinity are from the lower three layers.

This coal is also mined at the mouth of Floodwood Creek, where its thickness is in some parts reduced to 5′ 2″. This diminution is local, and farther on in the drift the seam attains 6′ 2″, while to the northeast, in section 4, it measures 9′.

§ 27. In the township of Dover, which adjoins York on the east, the great vein has sunk below water-level and is reached by shafts. On the line of the railroad in the southwest part of the township, near the mouth of Hamley's Run, the coal is extensively mined by a shaft of sixty-nine feet. I was informed that 6′ were extracted, leaving 2′ of inferior quality in the upper part of the seam. At Chauncey, in section 20 of Dover, and in Salina a little farther to the southwest, the coal is mined for the manufacture of salt, at a depth of one hundred feet, and has a thickness of 6′ and upwards. Nothing is known of this coal in the eastern part of Dover, and it is not improbable, from the observations at Athens, that it may thin out to the southeast.

§ 28. Coming now to the next range of townships to the north, we have Green and Ward in Hocking county, and Trimble in Athens county. The trend of the outcrop of the coal strata being to the east of north, the great vein is confined to the southeast part of Green, where it is found in the hills and is largely mined at Haydenville, with a thickness of 6′ 4″. Elsewhere in this vicinity it is 5′ 7″.

§ 29. The high lands of Ward everywhere contain the great vein. This township is traversed obliquely in its western part by Monday Creek, and along its eastern border by Snow Fork, a tributary of the latter. In the southern part of the township the coal is 6′ or a little more, but its thickness augments to the northward, and in section 24, near the northwest corner, on Lost Run it is described as being 10′ 6″. In the valley of Snow Fork, on the eastern border of the township, the coal is seen at various points measuring 7′, 9′ and 10′.

§ 30. Trimble township, which lies to the eastward of

Ward, is traversed in its eastern part from north to south by Sunday Creek, which passes thence nearly through the middle of Dover and falls into the Hocking in the southern part of this township. The great vein in the western part of Trimble is exposed along the valley of the Snow Fork, where in section 31 it measures 10′, but to the eastward sinks beneath water-level, dipping to the south of east at the rate of about thirty feet in a mile. In the southeastern part of the township in Sunday Creek valley a recent boring in section 7, showed the vein with a thickness of 8′ 4″ at eighty-four feet below the surface. In the southern part of the township borings have lately been made on Green's Run and Bayley's Run, showing the great vein 7′, 8′ 2″ and 10′ at depths of from eighty to ninety feet below the surface in the lower valleys. Some of these borings are in the northern part of Dover, but I have not the means of giving their exact localities. Various borings to the northward, along the valley of Sunday Creek in Trimble, show the great vein to be from 8′ 6″ to 12′ 2″.

§ 31. The next line of townships to the north includes, beginning at the west, Monday Creek township in Perry county with the narrow Gore of Falls to the south of it. To the east of these lies Salt Lick, followed by Munroe, both also in Perry county. In the first named of these townships the great vein appears in the hills in the eastern part, two and a half miles east of Maxville, with a thickness of 7′ 4″ to 7′ 8″. It is also said to be mined in the Gore.

§ 32. In Salt Lick, the great vein is largely mined, this township and York being as yet the only portions of the Hocking valley field in which important mining operations are carried on. A branch of the Columbus and Hocking Valley railroad from Logan, entering Salt Lick from the west, has its terminus at New Straitsville, while from the north comes the Newark, Somerset and Straitsville railroad, the present terminus of which is at Shawnee. Both of these

points are in the western part of the township, where the coal is found only in the hills, and is advantageously mined by drifting. The vein in this vicinity measures from 9′ to 11′, and includes two clay partings. In various other parts of the township its thickness varies from a little over 6′ to 9′ and 10′. The mines of the Straitsville Cannel Company of New York, in the eastern part of the township on the head-waters of the west branch of Sunday Creek, are said to have 10′ of coal on an average. In some parts of this township the coal for one or two feet in the upper part of the seam is slaty and pyritous, and this having been injudiciously mixed with the lower portions, gave for a time a bad repute to the Straitsville coal. This upper part is now in these cases rejected.

§ 33. A process of erosion during the deposition of the coal measures, and prior to the formation of the overlying coal seams has, according to Andrews, locally affected the great vein in the eastern part of Salt Lick township and the western part of Munroe on the tributaries of Sunday Creek. The shale, which usually forms the roof, is cut away, and in some cases, the coal itself, the seam being reduced to three or four feet, or entirely wanting, as in one locality in section 24 of Salt Lick. Andrews describes a case where the coal, with a thickness of 10′, has been cut sharply off. This work appears to have been done by currents flowing in channels which were subsequently filled up by sand. I have seen in York an irregular cavity in the upper part of the coal filled in this manner by sandstone, and similar cavities are also occasionally occupied by clay. The strata immediately above the great vein seem in many parts to have been considerably disturbed by this ancient erosion, but the breaks in the continuity of the coal seam itself are, according to Andrews, rare and of very limited extent.

§ 34. To the east of Salt Lick township lies Munroe, which is traversed from north to south by Sunday Creek. In the western part the coal occurs above water-level, and in

section 18, where it is exposed in a valley, shows 12′ 6″, with two partings measuring together 6″. To the north of this, in section 7, it is 12′, while in section 8 it attains a development of 13′ 2″, with 4″ of shale in two partings. In section 9 is an outcrop where it has long been mined for local use, and shows a thickness of 11′. In the eastern part of the township it is reached by borings; in section 15, near Ferrara, it was 11′ 6″ at a depth of twenty-nine feet, while in section 23, at a depth of fifty-three feet, the coal measured 10′ 10″, and in section 27 at sixty feet its thickness was 9′ 6″.

§ 35. To the north of the last range of townships we find Jackson, and to the east of these Pike and Bearfield, all in Perry county, together with the small township of Pleasant interposed, consisting of sixteen sections which are taken from the surrounding townships of Salt Lick, Munroe, Pike and Bearfield. The great vein of coal is traced along its western outcrop into the hills in the southeastern corner of Jackson, but is there reduced to a thickness of less than 4′. In Pike, near the village of Bristol in section 30, and again to the northeast in section 16, it is found in the hills, with a thickness of only 4′. In both places it shows the usual partings, and the upper portion is inferior. Beyond this it is known in the northern part of Pike at New Lexington on the Cincinnati and Muskingum Valley railroad, where also it has a thickness of about 4′. It is here mined to a considerable extent, and is known as the Upper New Lexington coal, to distinguish it from another seam twenty-three below it, which is also mined at this place.

§ 36. The Upper New Lexington coal, the diminished representative of the great vein, is traced through the western part of Bearfield, with a thickness of 4′ and 4′ 6″, and to the northward, at McLuney's station, in Harrison, on the C. & M. V. R. R. is mined, where it has a thickness of 4′ 8″, of which the upper 13″ are rejected. In the township of York, Morgan county, which joins Harrison on the east,

this coal is also seen with a thickness of 4′ 2″, and with the usual partings, and it has been traced farther northward into Muskingum county. Here it is mined in Newton, where, like the underlying seam, it is a caking coal. To the northeastward the Coal No. 6 is, according to Newberry, smooth, bright, very adhesive in the fire, and generally highly sulphurous.

§ 37. In the northeast part of Pleasant township the great vein is found with a thickness of 5′ to 5′ 6″, and as we follow to the southeast the valley of the Moxahala increases to 6′ and 7′, and finally, in the southeast part of the township, on the confines of Munroe, attains its full development of 11′ and 12′.

§ 38. We have thus followed the Upper Freeport, or Nelsonville coal, from the southward, where it is thin and unimportant, up to the townships of Brown, Waterloo and Athens, in which it has a thickness of 6′ or more, and thence northeastward along its western outcrop, through Starr, Green and Monday Creek, where it attains the same, or greater thickness, until in Pike or Harrison we have found it diminished to 4′, and deteriorated in quality, at least in the upper portion of the seam. Proceeding to the southeastward from the outcrop, we have seen it in York, Dover, Ward, Trimble, Salt Lick, Munroe and Pleasant townships, ranging from 6′ to 7′, 10′ and even 12′ and 13′ in thickness. We have found that in the southeast part of Munroe, in the greater part of Trimble, throughout Dover and Athens, and in parts of York and Waterloo, the southeastern dip of the strata carries the great vein beneath the water-level; while farther to the northwest it lies in the hills and has been removed from the lower levels. To the south and east of the townships named, nothing is known of this seam of coal, but it will probably be found to thin out in this as in all other directions.

§ 39. It will be noticed that this great development to the north and east of the Hocking is confined to the region

drained by the tributaries of this river, and the same is true of the portion to the south except Brown and small portions of Starr, York and Waterloo, from which the waters flow southwest to the Raccoon River. We are thus justified in applying to this region the name frequently given to it of the Hocking valley coal field.

§ 40. In estimating the area of this field, or rather that over which the coal of the great vein is to be found with a thickness of 6′ and upwards, it must be remembered that except in these parts in the southeast where it lies beneath the water-level, more or less of the coal has been removed in the erosion of the valleys. Without a careful topographical survey of the region, any attempt to determine the amount thus removed must be but a guess. It is, I think, probable that the areas of the coal lying in the hills of Starr, Green and Monday Creek townships, along the western border of the field, are not more than equal to the portions which have been cut away from the valleys of the townships to the eastward. Regarding these then as compensated for by the hills of the western townships, we may reckon as entire the townships of Brown, Waterloo, Athens, York, Dover, Ward, Trimble, Salt Lick and Munroe, including the southern part of Pleasant, which is, as it were, cut out from the last two named. We have thus an area of nine townships of thirty-six square miles each, equal to three hundred and twenty-four square miles. If from this, for the eastern part of the township of Athens, in which the great vein is not known, and its development doubtful, and also the southeastern part of Dover, of which the same may be said, we deduct twenty-four miles, we shall have three hundred square miles, as the area over which the great vein is known to extend, with its development of 6′ and more. This, though confessedly but an approximation, from the difficulty of estimating the amount removed by erosion, is probably rather over than under the truth.

§ 41. Along the western border of the Hocking Valley coal field, it is known that the lower coal seams of Jackson county, with their accompanying iron ores, are found. These lower coals appear in some parts at least, to be thin, and they have hitherto received but little attention, on account of their proximity to the great vein. The accompanying strata yield large quantities of iron ore, and it is not improbable that some of these lower coal seams may, as in Jackson county, be found valuable. There are, however, as we have already noticed in § 3, seams of coal in close proximity to the great vein, which require more particular notice. The first of these, being below it, we have designated as Coal No. 5. It is found to the southward, in Madison and Elk, Vinton county, from twenty-five to thirty feet beneath the Limestone coal, with a thickness of from 2′ to 3′, and in some places 5′. It was again seen in the same position beneath the outcrop of the great vein in the northern part of Brown, and in the southern part of Starr, where it appears in the bed of a creek, at an estimated distance of twenty-five feet below the great seam. I was informed that two wells, sunk in this part of Starr, had each passed through 4′ of this coal. From its position it is of course soon concealed to the eastward, but is seen at several points along the Hocking River, and was exposed several years since in digging the Hocking Canal, near Nelsonville, where it was said to be from 3′ to 4′ thick, and was found a good smith's coal. Near Lick Run, in fraction 18 of York, it was found by Andrews to have a thickness of 3′, and to lie twenty-seven feet below the great vein.

It is also seen in Green and Salt Lick townships twenty-five and thirty feet below the great vein, and occasionally shows marks of erosion before the deposition of the latter, as a result of which it is partially replaced by sandstone. To the northeastward, near New Lexington, its position is twenty-two feet below the great vein, and it measures 4′,

with a thin clay parting near the middle. It is here known as the Lower New Lexington coal, and both it and the overlying seam are extensively mined (§ 35). Still farther to the northeast the lower seam, or Coal 5, is mined in Newton, Muskingum county, with a thickness of 3′ 10″, and is a caking coal. The soft shales above this lower coal afford in some cases a fine clay for pottery, which is extensively made from it at Roseville, in Clay township, in the county just named.

§ 42. Within a distance of about 100 feet above the great vein there are found the two seams of coal already noticed in § 11 as Coals 6a and 7, which are of considerable importance in various parts of the Hocking Valley region. They will be best understood by beginning their study in the northeast part of the field, where these upper seams are more known than elsewhere. On the west branch of Sunday Creek, in section 24 of Salt Lick township, a seam of coal, here 2′ 6″, is seen forty-seven feet above the great vein, and another 100 feet above, which is 4′ in thickness. The lower of these is the Coal 6a or middle seam, which is mined a few miles eastward at the Norris bank in section 21 of Munroe, where it is 6′ in thickness and is known as the Norris coal. It is also mined farther northward in section 9 of the same township, where it is fifty feet above the great vein, and has a thickness of 4′, and is again seen near the village of Moxahala in section 29 of Pleasant township. Its place in this vicinity is from forty to forty-five feet above the great vein, and its thickness in one locality is 4′ 2″. Elsewhere it is reduced to 2′, and in the hills to the northwestward, towards New Lexington, it is generally wanting. At Ferrara also, in section 22 of Munroe, it is only a few inches in thickness, and farther south, from a boring made in the southern part of Trimble, it appears to be absent.

§ 43. To the southwestward, at Lick Run in fraction 18 of York, the Coal 6a again appears forty-seven feet above

the great vein. It has here a thickness, according to Andrews, of only 9″, but a mile and a half to the southwest appears with a thickness of 4′, and with a band of limestone eighteen feet above it. In several other localities in York this coal is seen wit' thickness of about 4′, and is mined for local use. In s a 19 the same coal was found in two openings to be 3′ 11″ and 4′ 6″. The position of this is here supposed to be forty or fifty feet above the great vein, and a still higher seam of 3′, representing Coal 7, was seen in some localities in this township.

§ 44. In the eastern part of York, and farther north in Ward, there appear to be some irregularities in these upper coals. Near the mouth of Meeker's Run, in section 10 of York, the two seams above the great vein are found, according to Andrews, the first of 3′, at twenty-five feet above, and the second of 4′, seventy-six feet above the great vein, while near Bessemer, in s tion 12, the first seam is found in its place, and the sec ould appear, from the description by Mr. Read, to be wa g. Again in the northeastern part of Ward, on Snow Fork, there is found, according to Andrews, a seam of 3′ twenty-five feet above the top of the great vein, followed, after twenty-seven feet, by about two feet of limestone, flinty at the top and carrying some iron ore. At sixty feet above the same horizon is a second seam of coal 4′ 3″, while still a third seam of 3′ 6″ occurs at ninety feet above the great vein. Lower down on Snow Fork, however, a seam of 4′ occurs forty-five feet above the great vein, and the outcrop of another is seen forty-five feet higher up, these measurements coinciding with those to the northeast in Munroe. These local differences are not improbably connected with the erosion which occurred near this part of the field during the deposition of the coal measures, as already described in § 33.

§ 45. The upper seam or Coal 7 which, as we have seen, occurs in the eastern part of York at seventy-six feet, and

in the western part of Salt Lick at one hundred feet above the great vein, has been mined in the latter vicinity for local use by Mr. Stallsmith for several years, and is known as the Stallsmith coal. It is seen in numerous outcrops in the hills bordering the upper Sunday Creek valley, at from twenty-five to forty-five feet above the middle seam. In section 10 of Munroe it measures 3′ 6″; in section 4 of Pleasant 4′, and in one locality in section 33 of the same township it is said to be 5′. The same seam is seen along the valley of Sunday Creek and its tributaries on the west side, from the northern part of Trimble to the mouth of the creek in Dover, where it is only five feet above low water. It has long been mined in this region, and from the openings on the stream of that name, is here known as the Bayley's Run coal. It is very regular and persistent, with a thickness of from 4′ 6′ to 5′ 3″, sometimes including a parting of 2″. The position of this seam above the floor of the great vein, is here, as appears from recent borings, from eighty-two to ninety-seven feet. From the absence of any notice of a seam of coal in these borings between the Bayley's Run coal and the great vein, the middle or Norris seam would here seem to be wanting. An irregular coal seam, varying from 10″ to 4′ in thickness, is described as occurring in this vicinity about thirty feet above the Bayley's Run or Stallsmith coal.

§ 46. The Bayley's Run, which we have designated as Coal 7, is, according to Andrews, the same with the Alexander seam of Muskingum county, and with the Lower Waterloo or Sheridan coal of Gallia and Lawrence counties, where its position is about seventy-five feet above the top of the Limestone coal, the representative of the great vein. The intermediate seam, Coal 6a, appears in some parts about thirty feet above the same base, and is known as the Newcastle coal. We have already traced these two coals from the northern part of the Hocking valley field into York. They are both seen in the outcrops above the great vein in Starr,

and in the northern part of Brown, and the lower one of these is supposed to be the seam which has been described as appearing with a thickness of 4′, above the great vein in several parts of York.

§ 47. To one of these must probably be referred the coal which is found at Carbondale in the northwest section of Waterloo, and which measures 4′ 2″, with two partings, yielding 3′ 10″ of coal. This seam is extensively mined and shipped by the Carbondale branch of the Marietta and Cincinnati railroad. The same seam, according to Andrews, is traced a little east of south to Mineral City station on the railroad just named, where it measures 2′ 6″, and farther southwest to King's Switch, where also it is mined to a considerable extent, and is 2′ 7″. Still farther westward at Moonville, and again at Hope Furnace station and beyond, what is regarded by him as the same seam of coal, is seen with a thickness of 3′ 6″. The seam which is mined at these localities in the western part of Waterloo has been regarded by Andrews as the great vein, but this, along the line of the railroad near the western border of Waterloo, according to the result of the boring given in § 22, is found, with its usual thickness, seventy feet below the level of the valley, so that the Carbondale coal must be one of the higher seams. The outcrops of one, and in some places two, of these higher seams, are seen in various points in the township of Brown, and judging from the valuable qualities of the Carbondale coal, deserve a careful examination.

§ 48. The elevation of the great vein at its western outcrop at Haydenville is, according to Mr. W. H. Jennings, the engineer of the Columbus and Hocking Valley railroad, three hundred and seventeen feet above Lake Erie; at Brooks's Mine, near Nelsonville, one hundred and ninety-seven feet above; at Salina, in the southwest corner of Dover, in a shaft of one hundred and ten feet, fifteen feet below Lake Erie; while at Athens in a shaft two hundred

feet deep it is one hundred and eighteen feet below the same zero point. This position is fifteen miles S. 50° E. from Haydenville, and the descent of the great vein is thus four hundred and thirty-five feet, or twenty-nine feet to the mile. From these and other levels as data, Col. Whittlesey has determined the dip of this coal seam over various parts of the Hocking valley field. Some of his results are as follows:

A triangle connecting Haydenville, Old Straitsville and Buckingham, gave a dip to the great vein of S. 77° E., 25¾ feet to the mile; there are some local undulations in the dip near Straitsville. Another triangle connecting New Straitsville, Chauncey, and Ferrara, gave S. 74° E., 32 6-10 feet to the mile. A third connecting Old Straitsville, McCuneville and Buckingham gave S. 62½° E., 30 feet to the mile. A fourth connecting McCuneville, Moxahala and Bristol Tunnel on the Newark, Somerset and Straitsville railroad gave S. 67° E., 24 feet to the mile; while a fifth between the last mentioned tunnel, Moxahala and Koon's Tunnel near New Lexington gave S. 66½° E., 21½ feet to the mile.

§ 49. To the southward two triangles are given; one connecting Brooks's mine near Nelsonville, Mineral City and Athens, which gives S. 79° E., 36 4-10 feet to the mile; while another connecting the first two stations with Chauncey gives S. 78° E., 32 feet to the mile. If however I am right, as I endeavored to show above, in supposing the coal at Mineral City to be not the great vein, but an upper seam, these last two determinations are erroneous, and the dip to the southward augments more rapidly than has been supposed.

THE COALS OF THE HOCKING VALLEY.

§ 50. Although, as we have seen, the Hocking Valley coal field contains not less than four workable seams within a thickness of less than one hundred and fifty feet, comparatively little is known of the coal of any of these but the great vein, or No. 6. It is true that on the northern border of the field the coal No. 5, which has already been noticed in § 41, is mined to a considerable extent near New Lexington, and in addition to these, No. 6a and No. 7 are mined for local use in some parts of the field, and will be noticed farther on. It is, however, the coal of the great vein, which from its thickness, its purity and its many uses, is the characteristic coal of the field, and it is this alone which in the markets of the west is known as the Hocking coal, a name given to that mined near the banks of the Hocking. From the more northern part of the field the coal of the same vein is known by the names of Straitsville, Shawnee, Sunday Creek and Lyonsdale coal. Mining operations for exportation are as yet confined to the township of Salt Lick in the north, and in the south to openings along the line of the Columbus and Hocking Valley railroad in York, and adjacent points in Green, Ward and Dover townships.

§ 51. The Hocking coal, under which name we may conveniently designate the coal of the great vein throughout the Hocking valley field, belongs to the class known as dry, free-burning or non-caking coals, which do not soften and run together in burning. These coals are very distinct from those which become soft and agglutinate when heated; the latter are prized for blacksmiths' use, as they make what is called a hollow fire, and also are much esteemed for generating steam, especially on the Ohio steamboats, where the draft in the furnaces is so strong that an adhesive coal is preferred. Certain varieties of free-burning coals, mined

in northern Ohio and the adjacent parts of Pennsylvania, and also in Indiana, are locally known by the name of block coals, from the readiness with which, from the presence of joints at right angles to the bed, they divide into rectangular blocks. These coals are laminated in structure, and are seen to be made up of thin alternate layers of a bright and shining coal with others which are less lustrous. They often split readily in the direction of these layers, which are parallel to the bedding of the coal and have their surfaces covered with a soft black fibrous substance known as mineral charcoal. On the other hand, it is difficult to break them across the layers, and this fracture, as well described by Prof. E. T. Cox, in his account of the block coals of Indiana, "exhibits a splinty structure marked by alternate layers of dull and shining black coal." For this reason, apparently, the name of splint coal is given to this class of coals in Scotland. Their aspect is very different from that of fat caking coals, which generally break irregularly with broad, smooth, black and shining surfaces, although some caking coals are laminated.

§ 52. The Hocking coal is, like those just described, laminated in structure, with the characters of a splint coal, and burns with a bright flame, which is however less voluminous and smoky than that of cannel. It swells slightly, but instead of forming a cohering mass, breaks up and gives a body of glowing coals, which resemble those produced in the combustion of hard wood.

Numerous analyses of this coal from various parts of the field, show it to be unusually free from sulphur, with a proportion of fixed carbon varying from fifty-five to sixty per cent., and a comparatively small amount of ash. Its consumption, in 1873, amounted to considerably over a million of tons, and it is largely used as a steam-coal, both in locomotives and steamboats. It is also very favorably known as a fuel for puddling-furnaces and rolling-mills, and

in fact for all ordinary purposes. For household use it is much esteemed, not only in the west, but also in New York city, where it has been introduced within the last year or two under the name of Straitsville cannel. It is hardly necessary to say that it differs from cannel coal not only in its structure and its lustre, but in containing much less volatile matter and more fixed carbon, which give it a greater heating power than cannel. For household purposes it is perhaps best burned in deep grates such as are used for anthracite.

§ 53. The Hocking coal from the vicinity of Straitsville is also employed as a gas-coal in Columbus, Lancaster and Newark, Ohio, where it has replaced the Youghiogheny coal of Pennsylvania, formerly used for the purpose. According to a report of the superintendent of the Columbus gas-works, the gas made from the latter was equal in illuminating power to fourteen candles, while that from the Straitsville coal equals eighteen candles. This agrees closely with the photometric determinations of Prof. Wormley, the state inspector of gas, who gives from seventeen to nineteen candles. It was at first thought that the fact that a large part of the sulphur present in the coal goes off in the gas would be an objection to its use, but it is declared that the superior illuminating power of the gas more than compensates for the larger amount of lime required in its purification. According to one statement two thousand pounds of this coal yield eight thousand feet of purified gas, but from a report by Mr. W. Robbins, the president of the Newark Gas Company, the result of a trial of over eight tons of the coal from New Straitsville showed a product of nine thousand cubic feet to the ton of two thousand pounds. In case of working, the coal compares favorably with cannel, giving off its gas at a moderate heat, while the coke is of superior quality.

§ 54. One of the most important applications of dry or

splint coal is for the manufacture of iron in the blast-furnace. The ordinary bituminous or caking coals cannot be used in the raw state for iron-smelting, but require to be first made into coke, while the dry or non-caking coals, provided they are sufficiently hard and strong to bear without crushing the burden of the furnace, may be used directly in their raw state, like anthracite. The block or splint coal mentioned above is largely mined for this purpose in the Chenango valley in Mercer Co., Pennsylvania, and also in the valley of the Mahoning in northeastern Ohio, in both of which are large numbers of furnaces for smelting the rich iron ores brought from Lake Superior. This coal from near Youngstown in the Mahoning valley, known as Briar Hill coal, is also used for this purpose at Cleveland and at Newburgh in its vicinity, where Lake Superior ores are smelted by its aid, and yield an iron used for the manufacture of Bessemer steel. The Briar Hill coal is here used without any admixture of other fuel, but at Youngstown it is often mixed with a small amount of coke.

§ 55. The dry-burning coal of the Hocking valley field closely resembles in composition and properties that of the Mahoning valley, and has now been successfully used for some years in blast-furnaces at Columbus and at Zanesville in Ohio. The former of those, the furnace of the Columbus Iron Company, which has now been smelting since 1871, measures sixty-one feet in height, and fourteen and a half feet at the boshes; its capacity is thirty tons a day. The ores used are a mixture of about one-third of native carbonates and limonites with two-thirds of the rich hematites of Missouri or Lake Superior. The fuel is the coal from the great vein, mined at New Straitsville, and the whole thickness of the seam is used. This coal has been used without admixture, requiring seventy-five bushels to produce a ton of iron, but with the above proportions of ores the best results are obtained with an addition of one-third

of Connellsville coke. The amount of iron produced in 1873 was 8,466 tons. The product, in part foundry and in part mill iron, is declared to be equal in all respects to that made with Briar Hill or with Indiana block coal. These details are partly from the report of the geological survey of Ohio and partly from a recent private letter from the late president of the company, S. Baird, Esq., who is now about erecting a furnace in Monday Creek township, to smelt the ores found in that vicinity with the coal of the great vein mined near its western outcrop. A second blast-furnace using the New Straitsville coal has lately been built at Columbus, and went into blast last autumn. Its production for November and December, 1873, is stated at 1500 tons.

§ 56. A third blast-furnace, that of Zanesville, Ohio, originally using charcoal, has, for the last two years or more, employed the Straitsville coal as a fuel. The ores here smelted are chiefly the native carbonates and limonites, yielding on an average, forty per cent. of metal, but in some cases an admixture of foreign ores is used, as at Columbus. The furnace is sixty-two feet high, and sixteen feet across the boshes, and its capacity is stated at fifty tons a day. These details are taken from a printed letter of General Samuel Thomas, the president of the company (the Columbus Rolling Mill Company), who further says "The coal works as well in the blast-furnace as any coal I ever saw used for the purpose. We make a soft strong iron, excellent for castings, and when the furnace is properly burdened, an equally good iron for merchant-bar or rails. When a very large production from the furnace is needed we use about one-third of coke." Its production in 1872 is stated at 14,000 tons.

§ 57. The coal from the great vein has also been used to a considerable extent in the blast-furnace of the Cleveland Iron Company, at Cleveland. A late private letter from the manager, Mr. W. A. Hooker, states that

they have several times used it when the supply of coal from the Mahoning valley has failed, and that in the spring of 1873, the furnace was run for three months with Straitsville coal. It is, he says, "desirable to use part coke—from one-seventh to one-fourth—the former ratio gives good results; whereas the Briar Hill coal does not require any coke, and is generally used alone." The latter, he remarks, contains a somewhat larger proportion of fixed carbon, and bears better the burden of the furnace. It is, however, clear that if not quite equal to the standard coal of the Mahoning valley, the Straitsville coal is capable of successfully replacing it with a small admixture of coke. Prof. M. C. Read of the geological survey of Ohio, declares, after comparative trials, that the Hocking valley coal burns drier and is harder than that of Briar Hill, and therefore stands less in need of an admixture of coke. There are doubtless variations in the quality of the coal in both of these regions, as will be shown for that of the Hocking valley in § 68. Its heating power, as might be inferred from the results of analysis, is a little less than that of the Mahoning coal, and consequently somewhat more of it is required to make a ton of iron. According to Col. Whittlesey of Cleveland, the average consumption of six furnaces, at Youngstown, smelting Lake Superior ores, is from two and a quarter to two and a half tons of Briar Hill coal to a ton of iron, and he estimates that from two and a half to three tons of the Straitsville coal are required to produce the same result.

§ 58. The value placed upon the coal of the Hocking valley field may be judged from its prices in the markets. At Chicago, to which it is largely shipped both from York and Salt Lick townships, the wholesale price of "Brooks's" Hocking coal, which is mined near Nelsonville, has been for some time past $8.00 per ton, Briar Hill and Erie coals being quoted at $8.00 and $8.50, while Indiana block coal is $6.50, and Illinois coal $5.00. In Indianapolis,

the wholesale price of Hocking coal, of late, has ranged from $4.20 to $4.40, while that of Indiana block, or Brazil coal, is from $3.65 to $4.20. In Cleveland, Ohio, where the Briar Hill has long been the favorite coal, and is now quoted at $4.00, Hocking valley is $3.75. The above figures are taken from the market reports in the numbers of "The Engineering and Mining Journal" of New York, for March and April. A recent private letter from Cleveland, in reply to an inquiry as to the comparative prices of the two coals, states that "while Briar Hill ranges from $4.10 (which is said to be the lowest), to $4.50 and $4.75, Straitsville is from $3.95 to $4.25." In New York city the wholesale price for the coal from the great vein, mined in Salt Lick township, and known as Lyonsdale coal, is quoted at $12.00, while the so-called Straitsville cannel is retailed at $16.00 per ton.

§ 59. We have next to consider the chemical composition of the coal of the great vein, as shown by the numerous analyses of Prof. T. G. Wormley, the chemist to the geological survey of Ohio. Some of these are to be found in the reports of the survey for 1869 and 1870, and a few later ones in the official report for 1873, and in two special reports by Prof. Andrews, also published in 1873. The greater number of these analyses are given below, but in some cases I have contented myself with giving the average of several. From a description given by Prof. Wormley in the report for 1870, we learn that the determinations were made as follows: the loss of weight in drying a portion of the powdered coal at 212° F. is regarded as water, and the loss by heating another portion of the coal to redness out of contact of air being ascertained, this, less the amount of water, is set down as combustible volatile matter; while the solid residue, less the weight of the ash left by complete combustion, is the fixed carbon. The weight of the coke may be got from the tables by adding together the ash and the fixed

carbon. Prof. Wormley has also, in many cases, given the amount of gas from the coal, calculated for a pound avoirdupois, from the results of treatment of five grains. These numbers are, however, as he has himself shown, below those obtained in the large way, and seldom exceed 3.5 cubic feet, while the same coals at the gas-works yield four feet and upwards. These determinations are therefore omitted in the following tables.

§ 60. The determinations of the amount of sulphur in coals are very important. We shall find given under this head, in many of the analyses below, first, the total amount of sulphur in 100 parts of the coal; second, the amount of this which remains fixed in the coke, and third, the quantity of sulphur which 100 parts of the coke will contain, marked "Sulphur, per cent. in coke." The color of the ash and the texture of the coke are also in most cases given. The amount of iron in the ash, as shown by its more or less red color, is generally supposed to be an indication of the proportion of sulphur in a coal, it being imagined that the sulphur exists in combination with iron as pyrites. That such is not always the case had already been in some instances shown, but Prof. Wormley has pointed out many examples of this. He determined in certain coals both the sulphur and the iron present, and in the case of coal No. 10, in table II, found the iron to amount to 0.38 parts, sufficient to combine with only 0.43, or less than one-third of the 1.42 parts of sulphur; while coal No. 12 of the same table contains only 0.09 of iron and 1.01 of sulphur.

§ 61. In some cases nearly the whole of the sulphur is given off at a red heat, while in other cases the greater part of it is retained in the coke; a distinction of much importance. For gas-making, those coals which retain the greatest amount of sulphur will yield the purest gas, while for iron-smelting, on the contrary, those coals which give off by heat the greater part of their sulphur are to be preferred,

since, even when used in their raw state, this ingredient is expelled in the upper part of the furnace, so that the coke, which, lower down, affects the reduction and the melting, is comparatively free from sulphur.

§ 62. The following tables of analyses show the variation in composition from the bottom to the top of the great vein, and also the diversities in various localities. Table I includes the analyses of coals from Nelsonville in York, and Haydenville in Green. In both of these the coal is from 6′ 0″ to 6′ 6″ in thickness, and is divided, as elsewhere, by two thin clay partings, into three benches. The lowest of these measures from 1′ 3″ to 1′ 7″, the middle from 2′ 4″ to 2′ 5″, and the upper from 2′ 0″ to 2′ 4″. Nos. 1–4 are from Brooks's mine at Nelsonville. 1 is an average sample of the coal, 2 the coal of the lower, 3 that of the middle, and 4 that of the upper bench. Nos. 5–7 are from Hayden's mine at Haydenville, 5 being from the lower, 6 from the middle, and 7 from the upper bench. In both cases it will be seen that the upper part contains the most ash.

I. COALS FROM NELSONVILLE AND HAYDENVILLE.

	No 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.
Specific gravity,	1.259	1.285	1.272	1.284	1.271	1.258	1.340
Water,	6.80	6.20	6.65	5.00	6.45	5.30	5.45
Volatile matter,	33.27	31.30	33.05	32.80	32.74	30.12	29.88
Fixed carbon,	57.46	59.80	58.40	53.15	58.56	63.49	55.31
Ash,	2.47	2.70	1.90	9.05	2.25	1.09	9.36
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur,	0.74	0.97	0.41	0.94	1.19	0.64	1.63
Color of ash,	Dull white.	Reddish.	White.	Yellowish gray.	Grayish.	White.	Reddish.
Nature of coke,	Compact.	Pulverulent.	Pulverulent.	Pulverulent.	Pulverulent.	.....	.....

§ 63. Going northward from Nelsonville about six miles, to Lost Run in section 24 of Ward, the great vein is found to have assumed a thickness of 10′, and we give below, in table II, the results of six analyses of portions of the coal from this locality, taken at regular intervals from the bottom to the top of the seam, as before. It will be seen here also, that the upper portions, Nos. 12 and 13, contain the most ash, while the lower eight feet, which, according to Andrews, are represented by Nos. 8–11, give but small amounts of ash.

II. COALS FROM LOST RUN IN WARD.

	No. 8.	No. 9.	No. 10.	No. 11.	No. 12.	No. 13.
Specific gravity,	1.278	1.290	1.257	1.284	1.287	1.274
Water,	7.15	6.80	5.85	6.15	5.80	3.05
Volatile matter,	35.28	36.16	37.10	33.22	35.42	38.39
Fixed carbon,	55.16	54.99	55.12	55.75	51.15	47.51
Ash,	2.41	2.05	1.93	4.88	7.63	11.05
	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur,	1.35	1.07	1.42	1.88	1.01	4.04
Sulphur left in coke,	0.81	0.79	0.51	1.00	0.50	2.02
Sulphur, per cent. in coke,	1.31	1.30	0.85	1.56	0.81	3.35
Color of ash,	Fawn.	Fawn.	Fawn.	Gray.	Cream.	Gray.
Nature of coke,	Compact.	Compact.	Compact.	Compact.	Very Compact.	Very Compact.

§ 64. Farther north, at the McGinnis coal bank at Straitsville, the great vein measures 11′, with two partings. The lowest bench is here 2′, the middle 1′ 8″, and the upper 6′ 10″, the partings being from 2″ to 4″ each. In table III, Nos. 14 and 15 are from the lower bench, No. 16 from the middle bench, and Nos. 17, 18 and 19 respectively from the bottom, middle and top of the upper bench.

III. COALS FROM OLD STRAITSVILLE.

	No. 14.	No. 15.	No. 16.	No. 17.	No. 18.	No. 19.
Specific gravity,	1.291	1.241	1.239	1.307	1.247	1.248
Water,	7.00	8.15	7.20	7.60	6.00	5.35
Volatile matter.	34.63	27.46	32.29	29.65	32.15	30.48
Fixed carbon,	54.29	61.73	59.44	52.77	59.41	57.21
Ash,	3.18	2.66	1.07	9.98	2.44	6.96
	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur,	0.98	0.78	0.73	0.68	0.50	1.22
Color of ash,	Dull white.	Reddish.	Reddish.	White.	Yellowish gray.	Grayish.
Nature of coke,	Compact.	.....	Pulverulent.	Pulverulent.	Pulverulent.	Pulverulent.

§ 65. From New Straitsville, where the seam has about the same thickness as at the last locality, we have four analyses of different portions of the seam from the bottom to the top. These are given in table IV under Nos. 20–23, counting from below upwards. Nos. 24 and 25, in the same table, are from the Benjamin Saunders coal-bank, in section 19 of Munroe. There also, the vein is over 10′ thick, the lower bench being 3′, the middle 5′ 9″, and the upper bench 1′ 11″. Of this, two analyses are given, one of the middle bench No. 24, and one of the upper bench No. 25 (this latter had been deprived of its water by drying at 212° F. before analysis). Of the coal of the middle bench, here so remarkably developed, Prof. Andrews remarks, that it is highly laminated, especially [illegible] lower 12″ and the upper 18″, charged with mi[illegible], and eminently fitted, from its large amou[illegible]rbo[illegible] for iron-smelting.

IV. COALS FROM NEW STRAITSVILLE AND FROM MUNROE.

	No. 20.	No. 21.	No. 22.	No. 23.	No. 24.	No. 25.
Specific gravity,.....	1.260	1.281	1.262	1.276	1.300	.....
Water,.....	7.70	7.40	7.20	5.30	5.60	.....
Volatile matter,.....	30.70	29.20	30.10	31.00	29.92	41.70
Fixed carbon,.....	59.00	60.45	57.55	55.75	62.45	55.50
Ash,.....	2.60	2.95	5.15	7.95	2.03	2.80
	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur,.....	0.49	0.93	0.57	1.18	0.76	2.56
Sulphur left in coke,.....	0.082	0.015	0.26	0.082	.....	.....
Sulphur, per cent. in coke,.....	0.13	0.023	0.41	0.128	.....	.....

§ 66. Besides the last two, we have many more analyses of coals from the great vein in Munroe, on the waters of Sunday Creek. From these analyses we take a series of five from the Welsh bank, in section 8 of Munroe, where the seam measures 13′ 2″, from which only 4″ are to be deducted for the two clay partings. The lower bench is here 2′ 9″, and the middle 5′ 9″, while the upper is 3′ 11″, and here, as elsewhere in Munroe and Salt Lick, is somewhat like cannel in its aspect. In table V, No. 26 is from the middle of the lower bench, Nos. 27–29 from the lower, middle and upper parts of the middle bench, and No. 30 from the middle of the upper bench. To these we add No. 31, the average of seven analyses from the bottom to the top of the Sands coal-bank in section 9 of Munroe, which measures 11′ 3″. Deducting from these the analysis of the top portion, which gives 11.26 per cent. of ash, the average of ash would be much less than above given. No. 32, according to Andrews, gives the average of not less than twenty-seven analyses which have been made of the coal of

the upper part of the Sunday Creek region, including those already given from No. 24.

V. COALS FROM VARIOUS PARTS OF MUNROE.

	No. 26.	No. 27.	No. 28.	No. 29.	No. 30.	No. 31.	No. 32.
Specific gravity,	1.312	1.385	1.300	1.316	1.302	1.300	.....
Water,	4.40	4.50	4.30	5.20	4.60	6.42	5.34
Volatile matter,	30.60	28.30	32.70	31.40	33.40	33.87	31.40
Fixed carbon,	62.30	53.50	58.80	58.40	57.30	54.17	58.17
Ash,	2.70	13.30	4.20	5.00	4.70	5.54	5.09
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur,	0.90	0.79	0.71	0.74	0.71	0.88	0.88
Sulphur left in coke,	0.43	.....	0.35	0.38	0.35	.....	.....
Color of ash,	Dull white.	Dull white.	Yellow.	Yellow.	Yellow.	.....	.....
Nature of coke,	Compact.	Pulverulent.	Compact.	Compact.	Compact.	.....	.....

§ 67. For the lower part of Sunday Creek, where the great vein lies beneath the water-level, we have only a few analyses of the coal taken from recent borings. Three of these, Nos. 33–35 in table VI, are on Green's Run and Bayley's Run, on the confines of Dover and Trimble (see § 45), while a fourth, No. 36, is from section 7 in the latter township.

VI. COALS FROM BORINGS IN DOVER AND TRIMBLE.

	No. 33.	No. 34.	No. 35.	No. 36.
Specific gravity,	.....	.....	.....	1.303
Water	4.70	2.10	4.85	4.10
Volatile matter	29.30	38.80	33.95	32.90
Fixed carbon	56.00	52.90	52.80	57.50
Ash	10.00	6.20	8.40	5.50
	100.00	100.00	100.00	100.00
Sulphur	0.60	0.77	0.60	0.79
Sulphur left in coke	0.054	0.22	0.21	0.49
Sulphur per cent. in coke	0.08	0.37	0.34	0.77
Color of ash	.....	.....	.....	Dull white.
Nature of coke	.....	.....	.....	Compact.

§ 68. It is much to be regretted that we have, as yet, no analyses of the coal of the great vein to the south and southwest of Nelsonville and Haydenville. By comparing the analyses of the tables I – IV, the important fact is seen, that while the coal of Straitsville and its vicinity is rich in fixed carbon, and contains but little sulphur, the coal a few miles south at Lost Run (table II) becomes rather more sulphurous, and contains more volatile matter, so that while equally good as a steam or gas-coal, it should be less suited for iron-smelting. Such, as I am told by the late president of the Columbus Iron Company, has been found to be the case in trials made at the Columbus furnace with the coal from this vicinity. Hence the prevailing notion that the coal to the south of Straitsville is not adapted to the smelting of iron. If, however, we proceed as far south as Nelsonville and Haydenville, we shall find that the coal of these localities contains as little sulphur and ash, less water, and at least as

much fixed carbon as the coals of Straitsville and New Straitsville; and, it may be confidently predicted, will be found equal to those in the blast-furnace. The dry-burning character of the coal of the great vein mined in Starr and at Lick Run in the western part of York is very marked. The coal from the latter mine when coked in a crucible shows no tendency to cohere, and its laminated structure is still seen on the charred fragments.

§ 69. The study of these very instructive tables of analyses makes it clear that there is a choice in the coal of different sections, according as it is wanted for steam, for gas-making or for iron-smelting, and shows moreover, the importance, in many cases, of making a selection in taking down the coal of the great vein. Hitherto in mining coal at Straitsville for the iron-furnaces the whole seam has been used, although there are, as we have seen, considerable differences in the benches. There is little doubt that by careful selection, it will be possible to get from the great vein of the Hocking valley a furnace-coal even better than any yet obtained.

§ 70. Little is known of the Norris or middle seam of coal to the north of the Hocking River. It is, however, mined for local use in parts of Munroe, where it has a thickness of 4′, and even 6′. Two analyses of this coal from section 9 of this township, are given by Prof. Wormley. One of these afforded water 3.80, volatile matter 38.80, fixed carbon 52.80, and sulphur 3.59; the other was somewhat more sulphurous. This coal in Munroe is described as dry-burning, though less markedly so than that of the great vein. The coal of this middle seam is also mined for local use in several localities in York, where its thickness is from 4′ to 4′ 6″. That from one of these openings in section 19, showed, when burned in an open fire, no tendency to soften, and was in fact a dry-burning coal. An analysis of it made for me by Mr. Stafford, gave, water 3.49,

volatile matter 39.50, fixed carbon 51.85, ash 5.16, and sulphur 2.09.

The coal mined at Carbondale and its vicinity, as described in § 47, is probably the same, and is, according to Andrews, a dry-burning coal, which is used for the locomotives on the Marietta and Cincinnati railroad, and for consumption at various points along the line, and is well esteemed.

§ 71. The upper seam, or Coal 7, is, unlike the great and the middle seams, a coking coal. It is bright and compact, softens and cements in the fire, and as it burns with a brilliant flame, is by the country people in many places preferred to the dry coal of the great vein. It is mined for local use in parts of Salt Lick, Munroe, Trimble and Dover, especially in the latter two townships, where the seam is opened at many points, and supplies with coal the whole of lower part of Sunday Creek valley. From this region it was shipped in boats by the Hocking and Ohio rivers to Cincinnati more than fifty years since.

In table VII are given analyses of this upper seam; the Stallsmith or Bayley's Run coal. No. 37 is from the Stallsmith bank, on section 19 of Munroe. The thickness of the coal at this opening is not given, but elsewhere in the same section it measures 4′ 8″, and has a thin pyritous layer 8″ from the top. Nos. 38 and 39 are from section 10 of Trimble (where also the seam is 4′ 8″), and represent the lower and middle portions; the upper part gave 2.96 per cent. of sulphur, and 3.40 of red ash. Nos. 40 and 41 are from section 7 of Trimble, and are taken from the lower and upper parts of the seam, while No. 42 is from Dover, section 34. In the vicinity of these last, as already stated in § 45, the thickness of this upper seam varies from 4′ 6′ to 5′ 3″. According to Prof. Wormley, the coal from this vein gives a very hard compact brilliant coke, which will probably be found well suited for metallurgical purposes. It may also be expected to prove a good gas-coal.

VII. ANALYSES OF COAL 7 FROM MUNROE, TRIMBLE AND DOVER.

	No. 37.	No. 38.	No. 39.	No. 40.	No. 41.	No. 42.
Specific gravity.....	1.254	1.301	1.264	.....	.....	.....
Water.....	3.80	5.00	4.80	4.30	4.50	4.20
Volatile matter.....	40.21	32.30	35.20	33.10	31.30	35.20
Fixed carbon.....	51.85	55.30	56.00	59.60	57.80	58.00
Ash.....	4.14	7.40	3.40	3.00	6.40	2.60
	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur.....	2.02	1.85	1.20	1.20	1.15	1.04
Sulphur in coke.....	.....	0.42	0.69	0.46	0.52	0.41
Sulphur; per cent. in coke	.....	.....	.....	0.73	0.80	0.67
Color of ash.....	.....	Fawn.	Reddish.	Gray.	Whitish.	Gray.

§ 72. The proportion of sulphur in Coal 7, though somewhat larger than that of the great vein, is not large when compared with most other coals in Ohio and elsewhere. From the analyses of Ohio coals published by Prof. Wormley, I select a few examples. The average amount of sulphur in seven samples of the coal mined at Cambridge, in Guernsey county, is 1.98 per cent; that of nine from Coshocton county, 2.21; of nine from Stark county, 1.94; of ten from Holmes county 2.15, and of seven from Columbiana county 1.95. Of the coals of Great Britain, as appears from an extended series of analyses made a few years since for the British Admiralty, the average amount of sulphur in thirty-seven Welsh coals was 1.42 per cent; of twenty-eight from Lancashire 1.42, of eight Scotch coals 1.45, and of seventeen from Newcastle 0.94. The coke of Durham, esteemed in England as the best fuel for iron-smelting, retains from 0.60 to 0.80 of sulphur, and the Connellsville coke about the same (§98).

So that it will be seen that the coal of the great vein of the Hocking valley, and even that of the upper seam, is more than ordinarily free from sulphur.

§ 73. On the contrary, the greater part of the coals in Ohio to the northward are unusually sulphurous. In the words of Dr. Newberry, "with the exception of the Briar Hill coal, there is probably no seam, which along its outcrop north of the National Road (which extends from Wheeling on the Ohio to Columbus) can supply a first-class furnace-fuel." The other coals of this region are, he tells us, usually caking in character, and only fit for the furnace after coking, They generally, moreover, contain so large a quantity of sulphur that they cannot be used for gas coals, and he adds: "It will be necessary that some process should be adopted for ridding our coals of the sulphur with which they are so generally contaminated, before they will become available for the most important uses." To this end he suggests that a process of washing and coking the crushed coal be resorted to (Report of Geological Survey for 1870, pages 43–44). It is hardly necessary to remark that this large proportion of sulphur detracts greatly from their value for all other purposes for which coal is employed, such as generating steam, puddling iron and household use.

§ 74. Some notice of the Briar Hill coal, as the only fuel in Ohio to the north of the Hocking valley coal which can be compared with it, will not be out of place. This name is given to a splint or dry-burning coal, which is No. 1 of the series, and is found at the base of the coal measures in portions of Mahoning, Trumbull, Columbiana and the adjacent counties to the west. It lies in small irregular basins, which were deposited on an uneven floor, and are separated by wide intervals. Prof. M. C. Read states that the average of workable coal in the districts over which this coal is supposed to extend will not exceed one-third of the area. An account of these irregularities will be found in his report on

Trumbull county (Geology of Ohio, vol. I, pages 494, 499). This coal is mined by shafts of from fifty to two hundred feet, and from the large amount of water in the mines the cost of extraction is considerably augmented. Lands holding this coal with a thickness of from 3′ to 5′ readily command from $500 to $1000 an acre, or a royalty of from thirty to seventy cents a ton for the coal mined, according to the locality and the facilities for shipment. It now costs, according to Col. Whittlesey, from $1.60 to $1.80 per ton when brought to the mouth of the shaft. The excellence of this coal and its superior fitness not only for iron-smelting but for most other purposes, not less than the prospect of the exhaustion of the deposits at no distant day, have combined to give to it the very highest value in the markets of the west as we have already seen in § 58. Both in northeastern Ohio and in the adjacent part of Pennsylvania, where also this coal is found, it is largely used as a furnace-coal. Some notion of the composition of this Briar Hill or block coal, as it is often called in the Mahoning valley, may be got from the analyses given on page 46 in table VIII.

§ 75. The name of block coal, suggested by the shape of the masses into which it breaks in mining, has been applied to a similar dry-burning or splint coal, which within the last few years has been mined in the western part of Indiana, on the eastern border of the great Illinois coal field, and as a fuel for iron-smelting is nearly equal to the coal of the Mahoning valley. It is, however, like this last, irregular in its distribution and interrupted by frequent intervals of barren ground. The latest details respecting this coal field will be found in a recent editorial from the pen of Mr. Eilers in "The Engineering and Mining Journal" for January 31, 1874. At Brazil, in Clay county, which is the part of the field as yet best known, there are, according to him, two seams of block-coal twenty-eight feet apart, and from three to four feet in thickness. The lower, being the firmer of the two, is

preferred for iron-smelting, but for this purpose, although it was at first used alone, it is now found advantageous to mix it with one-third of coke for the treatment of the Missouri ores, which are there smelted.

The cost of mining this block coal, including the stowing away of six inches of the roof, which falls of itself, was at the end of 1873, from $1.35 to $1.75 per ton delivered in the railway cars. This is exclusive of royalty or interest on capital, but includes all other expenses. The chief drawback to the successful working of this field according to the above writer, "is the great irregularity of the seams, which are in some parts of the field often wanting entirely, or so often interrupted by horsebacks that mining becomes too expensive to be profitable. Nothing but great numbers of bore-holes put down before mining in a certain tract is commenced can assure the miner in this field that his land actually contains the coal." Notwithstanding the apparent regularity of the strata, as a whole, "one or more coal veins may be present in full size on one farm while in the adjoining one not a trace of either may exist." The general composition of the block coal of Indiana may be seen from the analyses given on page 46 in table VIII.

§ 76. In the following table the first four analyses are of the coal of the Mahoning valley. No. 43 is a sample of Briar Hill coal from Chestnut Ridge; No. 44 from Veatch's mine, Youngstown; No. 45 from Walworth's mine, Mahoning county; while No. 46 is the average of six analyses of the block coal from Trumbull county. No. 47 is of a sample of the block coal from Brazil, Clay county, Indiana, while No. 48 is the average of seven analyses of the same coal from six different mines in Clay county, the extremes in the amount of fixed carbon in these being 61.5 and 53.0. These analyses, which are given by Prof. E. T. Cox in the "Report of the Geological Survey of Indiana for 1869," are incomplete, as they give us no indication of the proportion of sul-

phur present. The other analyses in this table are all by Prof. Wormley.

VIII. BLOCK COALS OF THE MAHONING VALLEY AND OF INDIANA.

	No. 43.	No. 44.	No. 45.	No. 46.	No. 47.	No. 48.
Specific gravity	1.284	1.260	1.323	.....	1.173	1.232
Water	3.00	2.47	3.90	3.65	5.46	6.10
Volatile matter	32.58	31.83	29.10	30.10	38.76	34.80
Fixed carbon	62.66	64.25	60.40	64.30	53.99	57.20
Ash	1.16	1.45	6.60	1.95	1.80	1.90
	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur	0.85	0.56	0.82	1.02	0.75	.....
Sulphur in coke	.....	0.48	0.60	0.61	.....	.....
Sulphur; per cent. in coke	.....	.....	.....	0.94	.....	.....

§ 77. In this connection should be noticed the coals of Jackson county, which have already been mentioned in §9. There are in Lick Township, according to Andrews, not less than three seams of dry-burning furnace-coals. The lowest of these, known as the Jackson Shaft-coal, is the equivalent of the Briar Hill of the Mahoning, and occupies the same position, being coal No. 1. Like this it lies somewhat irregularly, apparently conforming to the undulations of the underlying sandstone. Its thickness is from 3′ to 4′, and it is used for smelting in several furnaces in the vicinity. About thirty-six feet above is Coal 2, known as the Anthony or Sells coal, which also varies from 3′ to 4′ in thickness. Sixty feet higher is Coal 3 or the Hill-coal, as it is called in the vicinity of the town of Jackson, where it is used in admixture with Coal 1 in the blast-furnaces, and is from 2′ 6″ to 3′ 2″ in thickness. A seam of cannel is found about thirty

feet above the Hill-coal, and at seventy feet above Coal 3 is the blue or Putnam Hill limestone, which itself lies about eighty feet below the Limestone-coal, the representative of the great vein or No. 6, which would thus be about 250 feet, according to this estimate, above the Coal 1. From the irregularity of this last, however, the distance in some cases appears to be greater. It is worthy of note that the Limestone-coal, which in section 21 of Milton, has a thickness of 3′ 11″, with two clay partings of 1″ and 4″ has, according to Andrews, been used for iron-smelting in the Latrobe furnace.

§ 78. We give in table IX the analyses of some of the above coals. Nos. 49 and 50 are of the Coal 1, which, as it is mined by a shaft at the town of Jackson, is known locally as the Shaft-coal. No. 51 is a coal mined by shafting at Wellston, in section 6 of Milton, where it is said to have a thickness of 4′ 9″, without a parting, and has been used with very satisfactory results, without admixture, in a blast-furnace at Jackson. This analysis is by Mr. E. R. Taylor of Cleveland. It is not certain whether this is Coal 1 or Coal 2. Other analyses of it have given 62.0 and 63.0 per cent. of fixed carbon. No. 52 gives the average of three analyses from the bottom, middle and top of Coal 2 in section 33 of Washington township, where it is 3′ 2″. Another analysis of the same coal from the land of Mr. Anthony, in section 7 of Lick, where it is 3′ 6″ thick and known as the Anthony coal, gave not less than 63.5 per cent. of fixed carbon and only 1.50 of ash, besides 0.98 of sulphur, of which the larger part was volatile, leaving 0.57 in the coke. Nos. 53 and 54 are two analyses of the Coal 3 or Hill-coal of Jackson, where it is extensively mined.

§ 79. The value of furnace-coals, other circumstances being equal, depends upon their proportion of fixed carbon, and in this respect these remarkable coals, which are known over a considerable area in Milton, Lick and Washington townships, much exceed the block coals of Indiana, and equal the

best of that of the Hocking valley field. For the sake of comparison we subjoin an analysis of the Ashland coal, which is mined at Coalton in Kentucky, and is not only used for iron-smelting there, but is brought over to Ironton in Ohio for the same purpose. This is, according to Prof. Andrews, the Limestone-coal, the equivalent of the great vein of the Hocking valley, which though much reduced in thickness retains, as in Milton, its valuable properties. Its analysis gave to Wormley, water 6.65, volatile matter 36.54, fixed carbon 54.28, ash 4.53, and sulphur 1.07. A mean of this with three other analyses gives for the amount of fixed carbon of the Ashland coal, 54.90, which is considerably below the Hocking and Jackson furnace-coals.

IX. FURNACE-COALS OF JACKSON COUNTY.

	No. 49.	No. 50.	No. 51.	No. 52.	No. 53.	No. 54.
Specific gravity	1.282	1.267	.....	1.292	1.336	1.281
Water	7.75	7.50	.....	8.77	7.60	8.70
Volatile matter	31.27	30.90	30.14	28.33	30.96	28.30
Fixed carbon	58.95	57.50	59.26	61.78	57.65	61.60
Ash	2.03	4.10	1.60	1.12	3.79	1.50
	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur	0.53	0.74	0.40	0.75	0.49	0.57
Sulphur in coke	.....	0.22	.....	.....	.....	0.43
Sulphur; per cent. in coke	.....	0.34	.....	.....	.....	0.68

§ 80. We have now given a description of the Hocking valley coal field, and of the nature of its coal, and have, moreover, furnished the means of comparing this with some of the other coals of the west, which, in quality, may compete with it. In the case of those of the Mahoning valley and of Indiana, we have seen that their mining is effected

under disadvantageous conditions; the irregularities of the seams, their thinness and, in the first region, the presence of water, unite to augment their cost. If now we look to the Hocking valley we shall find, on the contrary, all the conditions favorable to the cheap and profitable extraction of its coal. Over by far the larger part of this field of three hundred square miles the coal of the great vein lies above water-level, while the upper vein is everywhere so. With the exception of a few points in the southeastern part of the field the coal is everywhere got by drifting, which, if done against the dip, affords a ready drainage. From the nature of the country, however, the surface-drainage is such that the mines are always dry. The thickness of the seam, from six feet upwards, is such as to allow great ease in working, and there is no expenditure necessary for cutting away the floor as in thinner seams. The roof of the great vein is a strong slate, and the rooms in mining the coal near Nelsonville are opened with a breadth of thirty and even thirty-five feet. The country, moreover, abounds in forest trees, and excellent hard wood for timbering the mines may everywhere be had on the land for the cost of cutting. The regularity of the floor, which is hard and dry, and the absence of rolls or undulations are also noticeable. The great vein is found with remarkable regularity, and only in two or three very limited localities has it been found interrupted for short distances (§ 33).

§ 81. The cost of opening a mine under these conditions is very small, since neither pumps nor hoisting-engines are necessary, although in many cases it will probably be found more advantageous to shaft for the coal and, raising it to the hill-tops, allow it to descend by gravity, than to draw it out over tramways for long distances to the openings in the valleys. The cost of the coal delivered in the railway cars at the present workings is not over $0.90 a ton, while it is, as we have seen, from $1.35 to $1.80 in the other

block coal regions. The price now paid for mining the coal in the Hocking valley is $0.03 a bushel or $0.75 a ton, and the miners here earn double the wages of those in the mines of northern Ohio and Indiana. When the wages of labor are reduced to the same scale as in these districts, the cost of producing coal in the Hocking valley will be considerably diminished. Brown's coal-cutter, lately introduced by Messrs. Niblack, Zimmerman & Alexander at their mines in Clay county, Indiana, promises to effect a great reduction in the cost of coal mining.

§ 82. In estimating the yield of these mines it will be well to give some data familiar to mining-engineers, which serve as the basis of calculations. The specific gravity of coal may be taken at 1.25, or one and a quarter times that of water, and a layer of such coal one foot in thickness will contain in an acre of superficies (4,840 square yards), 1,519 tons of 2,240 pounds or 1,690 tons of 2,000 pounds of coal. It is to be noted that while along the sea-board, coal is sold by the ton of twenty hundred-weight, to the west of tide-water in the United States the ton is reckoned at 2,000 pounds, and the bushel is estimated to contain eighty pounds, twenty-five bushels making a ton. It is at this rate that the miners, who work by the bushel, are paid, but the average weight of a bushel of most coals is less. Thus at Cincinnati a ton of Pittsburgh coal, which is there the standard, is supposed to measure twenty-eight bushels, while a ton of Hocking valley coal at Columbus is reckoned at twenty-seven bushels.

§ 83. The actual yield of coal in working a vein varies considerably. Thus in the anthracite mines of Pennsylvania, not more than two-thirds of the vein is got out in the condition of merchantable coal. In the Mahoning valley also the loss is estimated by Col. Whittlesey to be at least as great, so that from a vein of three feet in that region, 3,000 tons of coal to an acre is considered a good return. Much

better results than this are got by judicious working in favorable ground, and Warrington Smyth estimates that in Great Britain, on an average, about eighty per cent. of the coal is extracted. This, in case of long-wall mining, is of course exceeded, while in other mines the loss is as great as in the cases already mentioned. In the extensive workings of Mr. Brooks near Nelsonville in the Hocking valley, where the great vein, deducting the partings, gives six feet of coal, I am informed that his returns are at the rate of 7,200 tons per acre, equal to 1,200 tons of 2,000 pounds for each foot in thickness of coal. This, which is for merchantable coal, excluding nut-coal and slack, must be pronounced a fair result, though under the exceptionably favorable conditions offered by the great vein, there is no doubt that more skilful mining would increase this large production.

IRON ORES AND IRON SMELTING IN OHIO.

§ 84. Mention has been made in § 14 of the abundant iron ores which are interstratified in the coal measures throughout Ohio. It is, however, in the southern part of the state that they are best known and have been most developed. The first blast-furnace in this region was put in operation in 1827, near the village of Hanging Rock in Lawrence county, and from this, the industry having spread, the name of the Hanging Rock district has been extended to the whole iron-smelting region south of the Hocking valley, including parts of Vinton, Jackson, Scioto, Gallia and Lawrence counties. The number of blast-furnaces in this region in 1869 was forty-nine, of which five were using raw mineral coal and the others charcoal, and mostly of small size. Their production for that year is given at 106,000 tons of pig iron. I have not been able to get any authentic statements of a later date, the returns of the census for 1870 being very imperfect. I am, however, informed

that there are in the Hanging Rock region in 1874 sixty-five furnaces, built or building, including five now in construction for the use of mineral coal.

§ 85. These furnaces are almost entirely supplied with native ores, though some of those along the Ohio River use an admixture of ore from Missouri. By far the greater part of these native ores are from the bed known as the limestone-ore, from the fact that it rests upon the limestone which in this southern part of Ohio overlies the Coal 6 (§ 20). The thickness of this ore-deposit varies from a few inches to two feet or more. Where exposed to atmospheric action it has been converted into a hydrous peroxide or limonite, a reddish or brownish ore, but away from the outcrop it is still in the form of carbonate and is known as blue or gray ore. The so-called block ores of this region are also limonites. The carbonates contain, on an average, about forty per cent. of iron and the limonites from fifty to fifty-five per cent. The specific gravity of the limonite ores, as deduced from the examination of twenty-nine specimens from different localities, averages 2.90, and that of the carbonate ores, as a mean of forty-two specimens, is 3.37. These are calculated from the tables of analyses by Prof. Wormley, the greater part from the Hanging Rock district. It is usual before smelting these ores to roast them in heaps, by means of burning wood underneath, so that the volatile matters are driven off and the percentage of iron in the ore is increased. This is sometimes done before taking them to the furnace.

§ 86. These ores are got in some cases by stripping, as it is called, that is by removing the earth or the soft overlying rock from the layer of ore, when it lies near the surface. In other cases drifting into the rock is resorted to, and is extensively practised in parts of Lawrence county, where the limestone-ore is from six to eighteen inches in thickness. Twelve inches of ore can, it is said, be thus mined with

profit in hard sandstone, and even six inches in soft shales. If we take the specific gravity of the ore at an average of 3.125, or two and a half times the specific gravity of coal, it is clear that a continuous layer of ore one foot in thickness will contain as much as a seam of coal two and a half feet thick, or 4,250 gross tons. As the small broken ore is, unlike the slack of coal, not wasted, we may deduct for loss ten per cent., making thus the yield of a foot of ore 3,900 tons to the acre. But the thickness of the vein and the yield of ore are in some cases much greater than we have calculated. In section 22 of Elk township, in Vinton county, as stated in the geological report for 1870, the limestone-ore attains a thickness of from two and a half to three feet, and has been largely mined by drifting. Here 10,800 tons of ore were taken from less than two acres, and in another locality in this region, the yield of three acres is said to have been 23,000 tons of ore. Those who are obliged to purchase their ore pay from $3.00 to $5.00 a ton at the furnace, according to quality and locality (the limonites and block ores being richer than the carbonates) or $1.00 a ton for the ore in the bank, while those iron-smelters who own ore-lands get their ores much cheaper. The books of the Latrobe furnace in Milton showed for 1872, as the average cost of the ore mined upon the lands, and delivered at the furnace, and yielding forty per cent. of iron, $2.71 the ton of 2,240 pounds; in 1874 from $1.50 to $2.25 is there paid by contract for the mining of the ore. At some furnaces in Gallia county, the average cost of mining and delivering the ore at the furnace is stated at $2.50 per ton. The above data as to prices of ore and costs of mining are in great part furnished me by the kindness of Dr. Newberry, from unpublished notes, but in part also from data to which I am indebted to the proprietors of the Latrobe furnace. It will be seen from the above calculations that the value of a layer of ores like these, one foot in

thickness, in the vicinity of furnaces and of fuel for smelting it, is equal to that of a vein of coal of six feet.

§ 87. Besides the two kinds of iron ore already noticed, namely the carbonate or siderite, and hydrous peroxide or limonite, I have observed in this region a third species, not recognized in the reports of the geological survey. This is the anhydrous red oxide or red hematite, the same species as the Iron Mountain ore of Missouri, though not so pure. In my last visit to southern Ohio, I found this ore in nodular masses, scattered on the surface at Big Run in Rome, Athens county, and saw similar specimens from a few miles to the east, where I was informed it was in large quantities; its place being apparently above Coal 8. I subsequently received a mass of the same ore from section 13 of Brown, a little south of Hope Station, where it is said to be so abundant in large blocks, as to prevent the ploughing of the soil. The place of this would be between Coals 6 and 7. I was next shown the same ore from Wellston, in Milton township, where in sinking a shaft, a stratum of about two feet charged with nodules of it, was found, according to Mr. Harvey Wells, about thirty feet above Coal 1. The ore from these three localities is in rounded concretionary masses, which are dark purplish-red in color, giving a red powder, and so hard, in parts, as not to be scratched with a knife. In these respects, and also in its much greater weight, is very unlike the ores commonly mined in this region. A portion of the ore from Brown had a specific gravity of 4.475, and yielded by assay 61.00 per cent. of metallic iron, with only 2.0 per cent. of volatile matter. The similar ores from Milton and Rome have not yet been, so far as I know, assayed. Among the seventy or eighty published analyses of iron ores from the coal measures of Ohio given us by Prof. Wormley, I find included with the limonites a single specimen of an ore from Maxburg, Washington county, which apparently belongs to this species. It had a

specific gravity of 4.544, and yielded only 1.20 per cent. of water and 55.00 per cent. of metallic iron, besides some 18.00 per cent. of earthy matters, with no phosphorus. It would seem probable that from its unlikeness to the ordinary ores, this red hematite has been neglected by the miners. It is, however, even richer than the limonite ores, and much heavier, weighing about one and a half times as much as these, and if abundant, will prove a very important ore of iron.

§ 88. In the Hocking valley coal field, as already noticed, the limestone-ore of the more southern townships is no longer met with above the great vein of coal. The lower ores of the series are, however, found abundantly along its whole western border, and are extensively mined for the supply of the furnaces of Logan, Columbus and Zanesville. In Salt Lick township a layer of ore of considerable importance is found about thirty feet below the great vein; and a layer of nodular or kidney ore, found eight or ten feet below this coal, is very persistent throughout the region. To the west of Straitsville, where it lies in the hills, this ore is mined to a large extent by stripping, and sent to Logan and Columbus. Its price at Gore Station, on the railroad, is stated from $3.00 to $3.25 the ton. Considerable quantities of it have been got in like manner from near the mouth of Meeker's Run, in York, where it could, perhaps, be profitably mined by drifting. An average which I obtained by breaking several of the large nodular masses of the carbonate ore found here, afforded by analysis, metallic iron, 36.89; insoluble, 11.87; alumina, 2.82; lime, 3.56; magnesia, 2.49; phosphorus, 0.25; and volatile, chiefly carbonic acid, 27.82. This ore, after roasting, would contain 51.00 per cent. of metallic iron.

§ 89. At a height of fifteen or twenty feet above the middle or Norris seam of coal is a layer of ore associated with a thin band of limestone (already mentioned in § 44)

which is very well marked throughout the Hocking valley coal field, and according to Andrews, varies from 6″ to 14″ in thickness. I was, however, assured that in some parts of York it attains 20″, while near Bessemer, in section 12 of that township, according to Prof. M. C. Read, it measures not less than 4′ 7″. It has been mined to a considerable extent by stripping in parts of Brown, and to the northward in section 24 of Pike, appears in nodules disseminated through about three feet of shale and equal to from 10″ to 14″ of ore. Vast quantities of ore, according to Andrews, can be got from this seam in the northern part of the coal field. A specimen from section 4, in Pleasant, gave to Wormley 41.3 per cent. of iron, and a sample which I got from the hills a little south of Nelsonville, where it was a foot or more in thickness, gave metallic iron, 57.08; insoluble, 1.90; alumina, 0.33; phosphorus, 0.29; volatile, 12.29. It is a very pure limonite, and when roasted, would contain 65.0 per cent. of iron.

§ 90. In the upper part of Sunday Creek valley, in the townships of Pleasant and Munroe, is a marked horizon of iron ore about fifteen feet above Coal 7. Large blocks of carbonate, often of more than a ton weight, are found arranged in layers in the shales, and the supply is abundant, but the proportion of iron in it is small, amounting in two analyses by Wormley, to 23.8 and 26.1 per cent. Farther to the southward, however, the developments of iron ore lately made known by the observations of Prof. Andrews and the Rev. J. P. Wethee, are remarkable. As described in a recent report by the former, there are in the southeastern part of this coal field, not less than seven important horizons of iron ore between Coal 7 and Coal 8. The first, or lowest of these, is found in layers of large nodules in the shales from two to ten feet above the Bayley's Run coal, and is perhaps the same with that noticed above. It is principally in three layers, which in one place were estimated at 26″,

but in section 17 of Dover, are described as equal to over five feet of ore in a thickness of twenty feet of shales. A single specimen from this horizon, a carbonate partly changed into limonite, gave 33.7 per cent. of iron.

§ 91. About ten feet above the last occurs the second of these horizons of ore, which seems to be of much importance. It has been traced all over the western tributaries of Sunday Creek, in Trimble and Dover, and opened at twelve points for examination. It is described as more or less nodular, in from three to six layers which are imbedded in about six feet of red and yellow clays, and as yielding blocks often of several hundred pounds weight. In section 7 of Trimble, the aggregate of these layers is stated to be equal to a bed of 4′ 2″, and in three other localities to 2′ 4″, to 3′ 2″ and to 3′ 4″. The ore is a carbonate, partly changed into limonite, and gave in three analyses 41.57, 29.36 and 31.90 per cent. of metallic iron. These, like many others of the carbonates, contain considerable portions of lime and magnesia, which are useful as a flux for the silicious matters also present.

§ 92. A third layer of similar ore is just above the little seam of coal found thirty feet above Coal 7, and is said to occur like the last in several layers, equal to 3′ in the aggregate. Its analysis gave 28.97 per cent. of iron. A fourth layer of ore is sixty feet above the last and twelve feet above the so-called Cambridge limestone (§ 12). As seen in section 7 of Trimble this ore is a carbonate 12′ in thickness, and is associated with a layer of ferruginous limestone. Thirty-five feet above the last is the fifth horizon of ore, described as consisting of two massive layers having a united thickness of 3′. The sixth ore is about fifty feet above the Ames limestone, and is a layer of about 15″, while the seventh is ten feet higher, and about sixty feet below the horizon of the Pomeroy coal. It is seen in the highest hills in the southwestern part of the field "and ap-

pears to be several feet in thickness," though no openings have been made. The ore is described as "a brown hematite in nodules in ferruginous clay, and is apparently richer than any of the other ores found in this neighborhood." These last four ores have, however, not been assayed, and are but little known.

§ 93. It will be seen from the statements which have been given, that the quantity of iron ore in this region is very great, and that the supply within the limits of the Hocking valley coal field and along its borders will probably last as long as the coal itself, since each ton of these ores requires about a ton of coal to convert it into pig iron. The resources of this region for the production of iron are immense. There are no iron furnaces as yet in the Hocking valley coal field, the nearest being those of Zanesville, Columbus and Logan on the north and west, and those of Hanging Rock region to the southward. We have already described the furnaces of Columbus and Zanesville (§ 55). That at Logan is a charcoal furnace, which smelts ores got chiefly from the western part of Salt Lick and its neighborhood. These ores, brought by teams, cost in the raw state at the furnace, from $4.00 to $4.75 the ton. Two and a half tons of the raw ore or two tons of roasted ore make a ton of iron. Charcoal is also the fuel chiefly used in the furnaces of the Hanging Rock region, but the supply of wood is failing and the cost of charcoal is now, on an average, eight cents a bushel. It costs seven and a half cents at Logan, and, as I am informed from another source, varies in the Hanging Rock region from seven to ten cents, the lesser price being the cost to the smelters who make their charcoal. The ordinary consumption being here one hundred and fifty bushels to the ton of iron, the average cost of the fuel is $12.00 per ton. The time is not far distant when mineral coal will take the place of charcoal in this region.

§ 94. As already mentioned, five blast-furnaces, using

exclusively mineral coal, have been for some years in operation in the Hanging Rock region. Those about Jackson are of small size. The Orange furnace, built in 1864, is forty feet high, and produces about ten tons of iron daily. The more recent ones, using the Ashland coal from Kentucky, are larger, and the Ashland furnace on the Kentucky shore is sixty-five feet high, and makes thirty-five tons of iron daily, with a consumption of two and two-thirds of tons of 2,000 pounds, or 5,332 pounds of coal, to a ton of 2,268 pounds of iron. The above figures are from the report of the geological survey for 1870. In the Jackson furnaces the consumption of coal is stated at from seventy to eighty bushels to the ton of iron, and I was informed, that in some late trials with the coal from Milton (§ 78), during some weeks in the Orange furnace, sixty bushels only were used, while the product was declared in the Cincinnati market to be equal to charcoal iron. A double furnace for the use of this coal is now building at Wellston, where it is estimated that the cost of iron-making will be as follows:

Two and a half tons of ore at $2.75	$6.88
Sixty bushels of coal at 4½ cents	2.70
Three-quarters of a ton of limestone	.75
Labor	3.00
Interest and expenses	2.00
	$15.33

With a consumption of 150 bushels of charcoal at eight cents a bushel, the cost of fuel alone for the ton of iron will be $12.00, raising its cost to about $25.00, which must be considerably exceeded where charcoal is higher, or where, as appears from the figures of many furnaces in Lawrence county, the consumption is equal to 170 bushels of charcoal to the ton of iron. If, however, as we have good reason to believe, the coals of Jackson county and of the Hocking valley are the equals of that of the Mahoning valley for iron-smelting, the future of the iron-industry of southern Ohio is

assured for generations to come, and the cost of producing iron, will, from the abundant and cheap supply of both ore and fuel, be less there than in any other equally accessible part of the country.

§ 95. The iron from these native ores has long been highly esteemed for foundry purposes, while the cold-blast charcoal-made iron is especially prized for car-wheels, and commands a very high price. The ores of this region contain a variable amount of phosphorus, but so far as examined, in such a proportion as would unfit them for the manufacture of steel. I have had made by Dr. Drown of Philadelphia, determinations of the phosphorus and sulphur in two specimens of gray pig-iron, the one from the charcoal furnace at Logan, and the other from the Globe furnace at Jackson, with mineral coal. The results are as follows:

	Phosphorus.	Sulphur.
Logan furnace	0.44	0.100
Globe furnace	0.84	0.058

The proportion of phosphorus is not greater than might be expected from such ores, and it is noticeable that the smaller amount of sulphur is in the iron melted with mineral coal. The pig irons made from these ores of southern Ohio, though of superior quality for foundry purposes, and yielding excellent bar iron for all ordinary uses in the arts, are not fitted for the manufacture of steel for rails by the Bessemer process, for which, with some partial exceptions, the rich ores of northern Michigan and Missouri furnish our only native supply.

§ 96. The amount of iron ore mined in the northern peninsula of Michigan, and known as Lake Superior ore, is very great. Besides about 100,000 tons which are now smelted in the vicinity of the mines, there were shipped in 1872, 952,055, and in 1873 not less than 1,178,879 gross tons, yielding on an average 60.0 per cent. of iron. This latter amount of ore was, however, in excess of the demand.

Its price at Cleveland, Ohio, was $12.00 a ton in the beginning of 1873, but fell to $10.00 before its close, and will probably be $9.00 for 1874. This ore, which is shipped to various ports on the great lakes, is smelted, with small exceptions, by the coals of Pennsylvania and Ohio, and a very large proportion of it finds its way to Pittsburgh, to the Chenango valley in northwestern Pennsylvania, and to the valley of the Mahoning in northeastern Ohio. It is also smelted at Cleveland and, as we have seen, is carried to Zanesville and Columbus. The receipts of this ore at Cleveland, in 1873, are stated at 339,000 tons. The freight from thence to Pittsburgh, 150 miles, is $2.25 per ton.

§ 97. An iron ore equal in richness to that of Lake Superior, is mined in Missouri, chiefly at the Iron Mountain. There are no published returns from this region, but the production is very large. The price of the Iron Mountain-ore, which was $10.00 in 1873, is fixed for 1874 at $8.00 a ton at St. Louis. The ores of this region must be shipped to points where cheap fuel can be had for smelting them, and naturally find their way up the Ohio River as a return-freight on the numerous vessels employed in bringing down coal. As a result of this large quantities of these ores are brought to Pittsburgh to be smelted.

§ 98. Iron is smelted at Pittsburgh with Connellsville coke, of which 80 bushels or 3,200 pounds, with $1\frac{3}{4}$ tons of Lake Superior ore are required to make a ton of iron. In order to show the importance of this coke or a similar fuel for the metallurgy of the west it may be well to give some few facts with regard to it. The coal of the great Pittsburgh seam, which in the vicinity of Connellsville attains a thickness of from 9′ to 12′, is mined very cheaply. As there is no object in getting out large coal the vein is taken down at a cost of about $1\frac{1}{4}$ cents a bushel. This coal yields 65 per cent. of coke, 100 bushels of it producing 125 bushels of coke, which weighs forty pounds to the bushel. Its com-

position, as appears from an analysis of an average sample made from forty-nine pieces was as follows: carbon, 87.456; ash, 11.382; moisture, 0.490; sulphur, 0.693; phosphorus, 0.029 = 100.000. The ash contained 47.0 per cent. of silica, and 47.0 of alumina.* This coke is brought fifty-five miles by rail to Pittsburgh, and is there sold to western consumers for eight cents a bushel or $4.00 a ton. Its freight from thence to Cleveland, 150 miles, costs $2.25 per ton. The Connellsville coke, from its great density and its acknowledged excellence, supplies almost the whole market of the west, going as far as Chicago and St. Louis, and even to Utah, where it is used for smelting the silver-lead ores of that region. Some account of the magnitude of this commerce in coke will be given in speaking of the western coal trade (§105). Very little coke is now made in Ohio, and that chiefly at Steubenville, though the same Pittsburgh seam has been found to yield an excellent coke at Big Run, in Athens county, and, as we have shown in §71, the Coal 7 or Bayley's Run seam in the Hocking valley field gives, according to Prof. Wormley, a coke of superior quality.

THE COAL TRADE OF THE NORTH AND WEST.

§ 99. A knowledge of the coal markets of the north and west, their sources of supply and their growing demands is most important in relation to the Hocking valley coal field, and we accordingly give here some figures which help to throw light on this subject, gathered in part from data given in the recent valuable compilation by Mr. F. E. Saward of New York, entitled "The Coal Trade," and in part also from notes furnished by Mr. E. D. Mansfield of Cincinnati, Ohio. We will begin with Chicago, where the trade in coal has doubled within the last five years. The importations in 1869

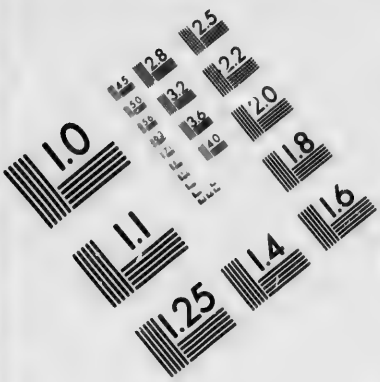
*I find this analysis in Saward's manual entitled "The Coal Trade," where the name of the analyst is not given.

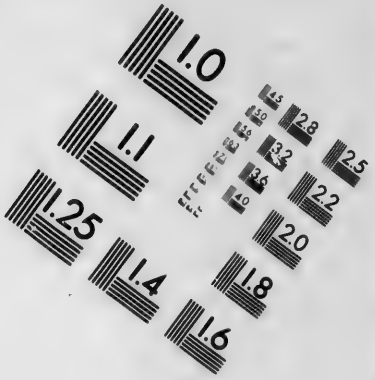
were 790,000 tons, and in 1873 amounted to 1,420,000 tons (of which 177,683 tons, or about one-eighth was redistributed), an increase at the rate of 20 per cent. per annum. The various sources of this coal in 1873 are shown in the following table:

COALS RECEIVED AT CHICAGO IN 1873.

	Tons.
In vessels by the lake	586,585
By Pittsburgh, Cincinnati and St. Louis railroad	167,630
Pittsburgh and Fort Wayne railroad	80,481
Lake Shore railroad	5,619
Chicago and Alton railroad	206,780
Chicago and Vincennes railroad	214,752
Illinois Central railroad	76,590
Chicago and Northwestern railroad	30,177
Chicago and Burlington railroad	28,832
Chicago and Rock Island railroad	15,346
Illinois Canal	7,213
Total	1,420,005

§ 100. Of the amount of coal received at Chicago by the lake, 90,982 tons were bituminous coal, and 495,765 anthracite. These, which together with the supplies by the first three railroads named, make up 840,315 tons, or in round numbers, three-fifths of the whole coal importation of Chicago, come wholly from the states of Ohio and Pennsylvania. The prices of coal in Chicago are much affected by the varying cost of lake-transportation. The freights from Buffalo, whence most of the anthracite and also the Blossburg coal is shipped, reached in 1872 as high as $2.50 per ton, during which time the average price of anthracite in Chicago was $11.00 the ton; while in 1873 the rate of freight opened at $1.00, rose to $1.18, and then rapidly declined during the financial troubles of the autumn, when coal was taken without charge as ballast. The result of this is that anthracite and other coal by the lakes during the past year has been usually low, the average price of anthracite being about $9.50 while that of all other coals, including those which come by rail, has been reduced accordingly. By lake are received not only the anthracite and the Blossburg coals, but the





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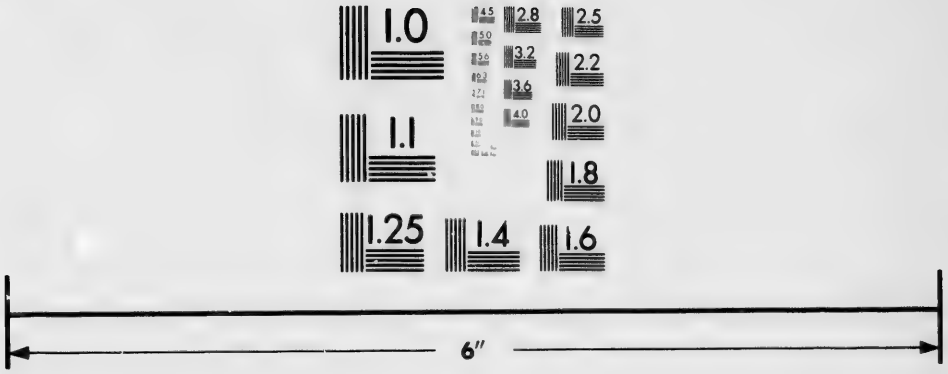

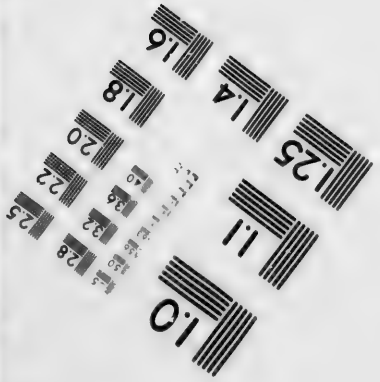

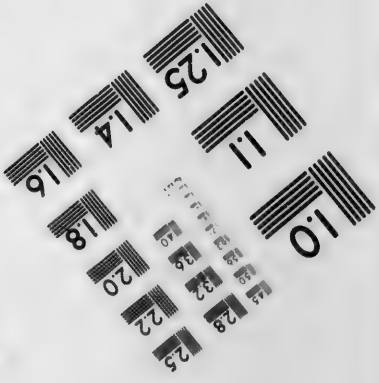

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Briar Hill coal from Mahoning valley, and the similar coal from Mercer county, Pennsylvania, which from the place of its shipment, is known as Erie coal. The Pittsburgh, Cincinnati and St. Louis railroad, and the Pittsburg and Fort Wayne railroad, bring to Chicago the coals of the Hocking valley, and also coal from Walnut Hill and Midway, Pennsylvania; while the remainder, equal to two-fifths of the coal-supply, comes from the adjacent coal field of Illinois and western Indiana. We have seen from the figures given in § 58 that these latter coals are less esteemed than others, since, while Briar Hill, Erie and Hocking valley are quoted at $8.00 to $8.50, the block coal of Indiana is $6.50, and the coal of Illinois $5.00. The reasons why Chicago gets the greater part of her coal-supply from the east are thus two-fold; first, the advantages offered by return-freights, both by lake and by rail, and second, the superior quality of the coals which are furnished by Ohio and Pennsylvania. The two gas-companies of Chicago now consume 90,000 tons of coal annually, and the four principal iron-works 126,000 tons.

§ 101. Milwaukee, which receives the whole of its coal-supply by the lake, imported, in 1869, 87,960 tons, and in 1873 not less than 210,191 tons, showing an increase at the rate of 35 per cent. per annum. A considerable iron-industry is springing up here. There were imported into Milwaukee in 1869, 12,180 tons of iron, and this rose last year to 49,000 tons; while there were produced in Wisconsin, in large part it is believed, with mineral coal, about 100,000 tons of iron against 67,600 in 1872. For Detroit the importation, altogether by the lake, for 1869, is estimated at 200,000, but amounted in 1873 to 370,500 tons, a yearly increase of over 20 per cent. Details of the coal imported into various parts of Ontario, such as Sarnia, Windsor and Port Stanley, are wanting, but the amount is considerable, and the demand in that county for coal is rapidly increasing with the great development of railways and of manufactures.

§ 102. Cleveland receives a great amount of coal, and is at the same time the seat of large manufactures, and a centre for the distribution of coal by the lake. Here come the coals from the Mahoning valley, from the Hocking valley, Massillon and other points in Ohio, and to some extent coal and coke from the Pittsburgh region. The figures of the coal trade of Cleveland, compiled from the returns of various transportation-companies, show a constant and regular increase both in the consumption and shipment of coal at this city. From the table given by Saward, we extract the following as the number of tons of coal received, shipped and used at Cleveland:—

	Received.	Shipped.	Consumed.
1865	465,555	236,000	229,550
1869	922,757	495,800	426,957
1873	1,599,212	854,862	744,350

The amount of coal received has thus more than trebled since 1865, the average annual increase in receipts since that date being at the rate of 31 per cent. while it has doubled since 1868, when 759,104 tons were received.

§ 103. Sandusky is destined to become an important port for the shipment of coal, being as will be seen, the nearest lake-port to the Hocking valley region. It began in 1872 with the shipment of 20,450 tons, which was increased in 1873 to 77,157 tons. Preparations for 1874 are made on a greatly extended scale for the shipment of coal, and for the reception of Lake Superior iron ore, of which 29,560 tons were brought to this port in 1873. There is little doubt that with proper railway and shipping facilities, a great trade, both in coal and ore, will here be built up in connection with the Hocking valley region. The same may be said of Toledo, when the railroads now in progress shall have opened more direct communications between this port and the coal field. It received, in 1869, 21,457 tons and in 1873, 37,868 tons of coal.

§ 104. Buffalo is a point of importance in relation to the coal trade in the northwest, and receives, besides large quan-

tities of coal from the eastward both by rail and canal, a very considerable amount from the west, partly by the Lake Shore railroad, and partly by vessels from ports in Lake Erie. Besides that required for the consumption of the city and its vicinity, amounting now to about 600,000 tons a year, a great quantity of coal is reshipped to Chicago, Milwaukee and other western ports as a return-freight in the vessels which bring grain to this port. Besides this, 67,210 tons were, in 1873, shipped eastward through the Erie canal, and by this route the coal of Ohio is beginning to find its way to New York. The returns of the coal trade of Buffalo for 1873 are as follows:

COAL TRADE OF BUFFALO FOR 1873.

	Tons.
Anthracite from the east by canal	254,044
Anthracite from the east by rail	479,885
Bituminous from the east by canal	125,000
Bituminous from the west by rail	190,000
Bituminous from the west by lake	85,139
Total	1,133,068

§ 105. We may now notice the coal trade of the Ohio, beginning however at Pittsburgh, which is the centre of a traffic which now equals about 160,000,000 bushels yearly, including the coal and coke which are mined and manufactured in its vicinity, and either consumed there or sent to various points, not only down the Ohio River, but eastward and westward by rail. There were shipped over the western end of the Pennsylvania railroad in 1872, 17,770,104 bushels of coal and 12,900,000 bushels of coke; the latter going west, while the greater part of the coal went east. Twenty-five years ago the entire annual production of the region was only about 4,500,000 bushels. The amounts of coal and coke received at Pittsburgh during three years are as follows:

COAL AND COKE RECEIVED AT PITTSBURGH.

	Bushels Coal.	Bushels Coke.
1870	67,388,725	11,594,000
1871	96,785,635	23,357,400
1872	115,065,140	43,927,765

The increase in the production of coal for these years is at the rate of 35 per cent. and that of the coke has doubled each year. We have already described the Connellsville coke and its extended use, in § 98.

§ 106. The receipts of coal at Cincinnati are given below from the returns of the Chamber of Commerce, and to these are added the prices of the coal as delivered for the last five years, the price of the coal afloat being about four cents less. Coal on the Ohio River is bought and sold by the bushel, and although Pittsburgh coal is calculated to weigh about seventy-six pounds to the bushel, twenty-eight bushels are reckoned the equivalent of a ton at Cincinnati.

COAL RECEIVED AT CINCINNATI.

	Bushels.	Average price.
1863-64	15,975,366	
1864-65	16,467,023	
1865-66	18,022,990	
1866-67	18,446,266	
1867-68	17,500,000	22.13 cents.
1868-69	25,500,000	19.69 "
1869-70	30,300,000	15.27 "
1870-71	22,972,000	15.82 "
1871-72	30,770,796	22.68 "
1872-73	37,274,497	20.72 "

The annual increase in the receipts of coal for the last five years has been at the rate of over 22.0 per cent. The various coals received for the year ending September 1, 1873 (amounting to 1,380,537 tons), are classified in the returns as follows:

	Bushels.
Youghiogheny coal	24,962,373
Ohio River and Kanawha coal	11,075,072
Cannel	1,162,052
Anthracite	75,000
	37,274,497

§ 107. The coal designated as Youghiogheny is that which is brought down from Pittsburgh, amounting to over two-thirds of the whole. A great part of the remainder comes from Pomeroy in Meigs county, and its vicinity. The annual coal-production of this county, according to Professor Andrews, is now estimated at 9,000,000 bushels. The coke

sold at Cincinnati in 1872–73 amounted to 3,594,820 bushels, some of which comes from Pittsburgh, while some more is made at Cincinnati. Of the coal received a considerable proportion is redistributed, being sent northward into the interior of the state, to various points within a radius of one hundred miles and more, to supply the increasing demand for coal in the country districts. This amounted in 1872–73 to 4,472,400 bushels, or 165,644 tons. The iron-manufacturing industries of this city, which consume a large quantity of coal, are of large and growing importance. In the absence of any other data it may be mentioned that the receipts of pig-iron at Cincinnati show a steady increase from 41,093 tons in 1869 to 130,795 tons in 1873.

§ 108. The price of coal at Cincinnati is subject to great fluctuations, as shown in the above table, where, however, the average for six years is 18.59 cents per bushel. Neither this nor the yearly averages serve to give a correct notion of the average cost of coal to the consumers, to determine which it would be necessary to know the amounts sold at each price. On September 1, 1872, the cost of Youghiogheny coal, delivered, was twenty cents the bushel. It rose, however, in October to twenty-seven cents, and reached in December twenty-eight cents, falling gradually from this time until in May it was sold at seventeen and eighteen cents, after which it rose again to twenty cents, which price it maintained with little change till September 1, 1873. These variations depend in great part on the state of the navigation of the Ohio, which is liable to be interrupted by ice in winter and by low water in summer. The unusually open navigation, coupled with the business depression has reduced the price of coal at Cincinnati, during the winter and spring of 1874, to a point seldom reached, Youghiogheny coal being from twelve to fourteen cents, delivered. Great fluctuations like these in the price of coal are obviously injurious to the manufacturing and commercial interests of a

business centre like Cincinnati, and a regular supply of coal not dependent upon the caprices of the river-navigation would be a great advantage. During the last year or two the Hocking coal has been to some extent brought to Cincinnati, though the railway connections with the mines opened in that region are far from direct. By the Marietta and Cincinnati railroad, the southern parts of the Hocking valley field are less than one hundred and sixty miles from Cincinnati, and the freight for this distance, at one cent and a quarter a ton per mile, the ordinary rate of freight for coal on the Ohio railroads, would be less than $2.00, while the coal can, as we have seen, be put on the cars in the Hocking valley for $0.90 the ton, so that it would be possible with proper means of transportation to lay down at all seasons, in Cincinnati, the superior coals of this region, at prices considerably below the average cost of the coals brought by river.

RAILWAY COMMUNICATIONS WITH THE HOCKING VALLEY.

§ 109. As yet the means of exporting coal from the Hocking valley are very inadequate. Previous to 1869, it was accessible only by the Hocking Canal, which runs from Columbus to Athens. The Columbus and Hocking Valley railroad, between the same points, was opened in that year, and has since shown a steadily growing coal trade, so that it is now in contemplation to lay down a double track with steel rails. The receipts of coal at Columbus, by this road, have been as follows, reckoning as is there done, twenty-seven bushels to the ton.

	Tons.
1870	50,000
1871	250,000
1872	600,000
1873	804,000

Columbus consumes a considerable proportion of this coal

in manufactures, and the remainder is sent by rail to various points and largely to Chicago. The Newark, Somerset and Straitsville railroad, opened in 1872 to Shawnee, carried to Newark in 1873, 300,000 tons of this coal, of which a large portion went to the lake-ports.

§ 110. These are as yet the only two outlets from the Hocking valley coal field, but the importance of the region has led to several new lines which are in process of construction, while others are projected. Of the former we may mention first the Atlantic and Lake Erie railroad, destined to connect Toledo on Lake Erie, with Pomeroy on the Ohio River, which will pass through the eastern part of the coal field down the valley of Sunday Creek, by New Lexington, Moxahala and Ferrara, thus connecting this part of the field directly both with the lakes and the river. By this route, now building, the distance from Toledo to Ferrara will be 174 miles; while by the present connections it is 198 miles from Toledo to Shawnee by the way of Newark, and from Toledo to Straitsville by the way of Columbus, 183 and 190½ miles by two different lines.

§ 111. Another railroad is now being built by the Pennsylvania railroad company from McLuney, a station five miles east of New Lexington on the Cincinnati, Wilmington and Zanesville railroad (which is controlled by that company) to Moxahala and thence to McCuneville near Shawnee on the Newark, Somerset & Straitsville railroad, thus giving a direct communication from the coal field to Zanesville. In connection with this a short portion of road between Dresden and Oxford will give the Pennsylvania railroad company a direct line from the coal field, by the way of Zanesville, to Cleveland. The coal from this field has hitherto reached Cleveland through Shelby on the Cleveland, Columbus & Cincinnati railroad, either by the way of Newark, from Shawnee, a distance of 181 miles, or from New Straitsville, by Columbus, 197 miles. By the new route through

Zanesville the distance from Ferrara, in the centre of the Sunday Creek valley, to Cleveland, will be but 164 miles. It is also proposed to build a few miles of road from Oxford to Loudonville on the Pittsburgh, Fort Wayne and Chicago railroad, which will effect a good connection with the lines of that company to Sandusky, Toledo, Chicago and the northwest.

§ 112. The Newark, Somerset and Straitsville railroad is now leased to the Baltimore and Ohio railroad company, which also controls the Marietta and Cincinnati railroad. From the Carbondale branch on this latter an extension is about to be built a distance of twenty-two miles through York and Ward, passing up Monday Creek and Snow Fork valleys, to Shawnee, the present terminus of the N. S. and S. R. R., from which point a road is projected eastward by Buckingham to Ferrara. From Newark to Sandusky, a direct line is now opened by the way of Mansfield. The Baltimore and Ohio company is also constructing an independent line from Newark to Chicago, passing through Fostoria, and now built nearly as far as Defiance, thus giving a direct connection between Chicago and the coal field, independent of the Pittsburgh and Fort Wayne railroad over which a large amount of coal from it is now sent, passing by an indirect route from Columbus to Crestline. A projected road from Columbus, by Bellefontaine, joining the Pittsburgh and Fort Wayne railroad at Lima, will make the communication between this coal field and Chicago, still more direct, while another projected line passing by Marion and Fostoria, will also give a direct connection between Columbus and Toledo. This latter city will become important for the coal trade, both as a shipping-port and as a point whence coal can be sent by the railways diverging northward and northwestward to Detroit and throughout the state of Michigan.

§ 113. Columbus will also serve as a centre for the distri-

bution of this coal to some of the western and southwestern parts of Ohio and Indiana. The distance by rail from New Straitsville to Dayton, *via* Columbus, is 134 miles. From Dayton to Ferrara by the Cincinnati, Wilmington and Zanesville railroad (also known as the Cincinnati and Muskingum Valley railroad) and an incompleted link from Washington on this road, to Xenia, will however be but 118 miles.

§ 114. From Logan on the Columbus and Hocking Valley railroad, another line is now partly graded, passing southward, through Starr, along the western border of the coal field to the Marietta and Cincinnati railroad, which it will intersect at Vinton. It is destined to reach the Ohio River at Gallipolis; while from Hampden on the M. and C. R. R., a line now runs to Portsmouth on the Ohio. The M. and C. R. R. crosses the southern, and as yet unopened part of this coal field in Brown and Waterloo, not more than 150 miles from Cincinnati, while by the extension of the Carbondale branch of this road through York to Shawnee, the present mines on the banks of the Hocking River will be about 160 miles from Cincinnati. From this city to Ferrara by the Cincinnati and Zanesville railroad, the distance will be 157 miles.

§ 115. These railway lines, as Col. I. B. Riley, of Newark has well said, "place all the principal coal-markets of Ohio nearly equidistant from this field, making the distance to Sandusky and Cincinnati about 160 miles each, and to Cleveland and Toledo about 170 miles, and furnishing competing routes to each place." The usual rate of charge for coal over the Ohio roads is one and a quarter cents per mile, per ton, so that the carriage to these points will not vary much from $2.00 per ton. Adding to this $0.90, the average estimated cost of mining the coal of the great vein, including the expenses at the coal bank, this coal will then cost, delivered at the principal points of consumption and of the shipment in Ohio, about $3.00 per ton.

CONCLUSION.

§ 116. Having shown the present and the prospective facilities for communication with the west and northwest from all parts of the Hocking valley coal field, it now only remains to make, in conclusion, some remarks on its importance in a near future as a source of coal. By recapitulating the results of the inquiry made in previous pages into the coal trade of the west, it will be seen that excluding Buffalo and Pittsburgh, for the reason that they are furnishers of coal to the more western points, we have for the amount of coal received at the cities named below in 1873, and for its annual rate of increase for the five years up to that date, the following figures:

	Tons in 1873.	Annual increase.
Cincinnati	1,380,537	22 per cent.
Cleveland	1,599,212	31 per cent.
Chicago	1,420,005	20 per cent.
Milwaukee	210,191	35 per cent.
Detroit	370,500	20 per cent.
Sandusky	77,157	
Toledo	37,688	
	5,095,290	

Of the above amount, some small part, having been shipped from ports on Lake Erie to those farther westward, is reckoned twice, but this is far more than compensated for by the consumption of the inland cities and towns of this rich and populous region as far west as Indianapolis and beyond, so that it will, I think, be no exaggeration to take the whole coal-consumption of the region thus supplied at 6,000,000 tons. From the figures above given, it will be seen that the average annual increase of the receipts at the three great centres was, for the last five years, over twenty-five per cent., and with the rapid growth of the west in manufacturing industries of all kinds, its railways and its steamboats, it may be confidently expected that this rate of increase will continue for many years to come. If, however, we put for the whole of the region

to be supplied the annual increase at only twenty instead of twenty-five per cent., we shall find that in place of the 6,000,000 of tons consumed in 1873, there will be required in 1880, or seven years hence, 14,400,000 tons of coal.

§ 117. When is this great supply of coal to come? A large proportion will continue to be sent from Pennsylvania and northern Ohio, and doubtless the Illinois and Indiana coal fields, notwithstanding the drawbacks as to quality of coal and to difficulties and costs of mining, will yield an increasing contingent, but Ohio, from its geographical position, and from the course of trade, must continue to furnish an increasing proportion. It has, however, been shown that the coal formation of this state in its northern half has, with the exception of the Mahoning valley region, with its single thin and interrupted vein of Briar Hill coal, yielded little except coals of inferior quality, and that it is only in the Hocking valley region that we have, in the great vein, an abundant supply of good coal free from sulphur and fit alike for all ordinary manufacturing and household purposes and for the smelting of iron. When we take into consideration all these circumstances it seems difficult to overestimate the importance of the Hocking valley coal field, from which a great portion of the west and northwest must draw the chief part of its coal-supply for generations to come. If the views of Mansfield and of others, who have carefully studied the coal trade of Cincinnati, be true, this city can be better and more cheaply supplied with coal from the Hocking valley than from Pittsburgh, and thus be rendered independent of the long and uncertain navigation of the upper Ohio; while it is probable that the lower portion of this river and the Mississippi may get from the Hocking valley field, by the way of Portsmouth and Gallipolis, a large part of its coal-supply.

§ 118. The coal of Ohio may, in its geographical, commercial and industrial relations, be compared to the anthracite

of Pennsylvania. The latter, occupying an area of about four hundred and seventy square miles, placed on the eastern border of the broad Appalachian basin, has before it to the north and east the great, rich and populous, but coalless states of New York, New Jersey and New England, which look to it for their chief supply of fuel. Moreover, in New York, in New Jersey and in eastern Pennsylvania are immense deposits of rich iron ores, which find in the anthracite the fuel necessary for their reduction and manufacture. As a result of this we find that the amount of anthracite mined in 1872 was 19,000,000 tons, or nearly one-half the whole coal-production of the United States, which amounted to 41,000,-000 tons.

If now we turn to the west we find on the opposite border of the Appalachian basin the coal region of eastern Ohio, and particularly the Hocking valley coal field, with its three hundred square miles of superior and easily mined coal, sustaining similar relations to the rich and populous but coalless states to the north and west, which must in time to come look to it for the supply of a great portion of their fuel. In addition to this we have, as a further resemblance, the vast supplies of iron ores, not only those of southern Ohio itself, but those of Lake Superior and of Missouri, which, with the development of an export-trade in coal from this region, will find their way thither in increasing quantities to be smelted and manufactured. In view of all these facts we may with confidence expect to see this coal field and its vicinity the seat of a metallurgical industry comparable to that of the Lehigh valley and of Pittsburgh.

APPENDIX.

ON THE COSTS OF IRON-SMELTING.

In § 94 we have given an estimate by Mr. Harvey Wells, making the cost of producing pig iron at the furnace now building in Milton, where the ores and coal will both be mined on the furnace-lands, less than $16.00 per ton. In this estimate, besides $0.75 for limestone to be used as flux, the costs of labor and wear and tear, etc., are counted at $5.00. This latter figure will vary considerably according to locality, and is the same as that given by Messrs. Cooper, Hewitt & Co., for Ringwood, New Jersey, where the magnetic ores of the region are smelted with anthracite and iron is made very cheaply. At Pittsburgh, Pennsylvania, according to high authority, the estimate for these expenses (including limestone for flux) is $8.00, instead of $5.75, as given for Milton. The price of Lake Superior ore being $9.00 a ton at Cleveland, and $2.25 added for freight thence to Pittsburgh, making $11.25, the cost of $1\frac{2}{3}$ tons of ore, required to produce a ton of iron, will be $18.75. Adding to this the cost of $1\frac{3}{5}$ tons, or eighty bushels of Connellsville coke at eight cents, or $6.40, and $8.00, as above, for other expenses, we have $33.15 as the cost of a ton of pig iron at Pittsburgh. The iron masters of this region, however, making their own coke at Connellsville,* get it delivered at Pittsburgh for about six and a half cents, which would reduce the ton of iron to about $32.00.

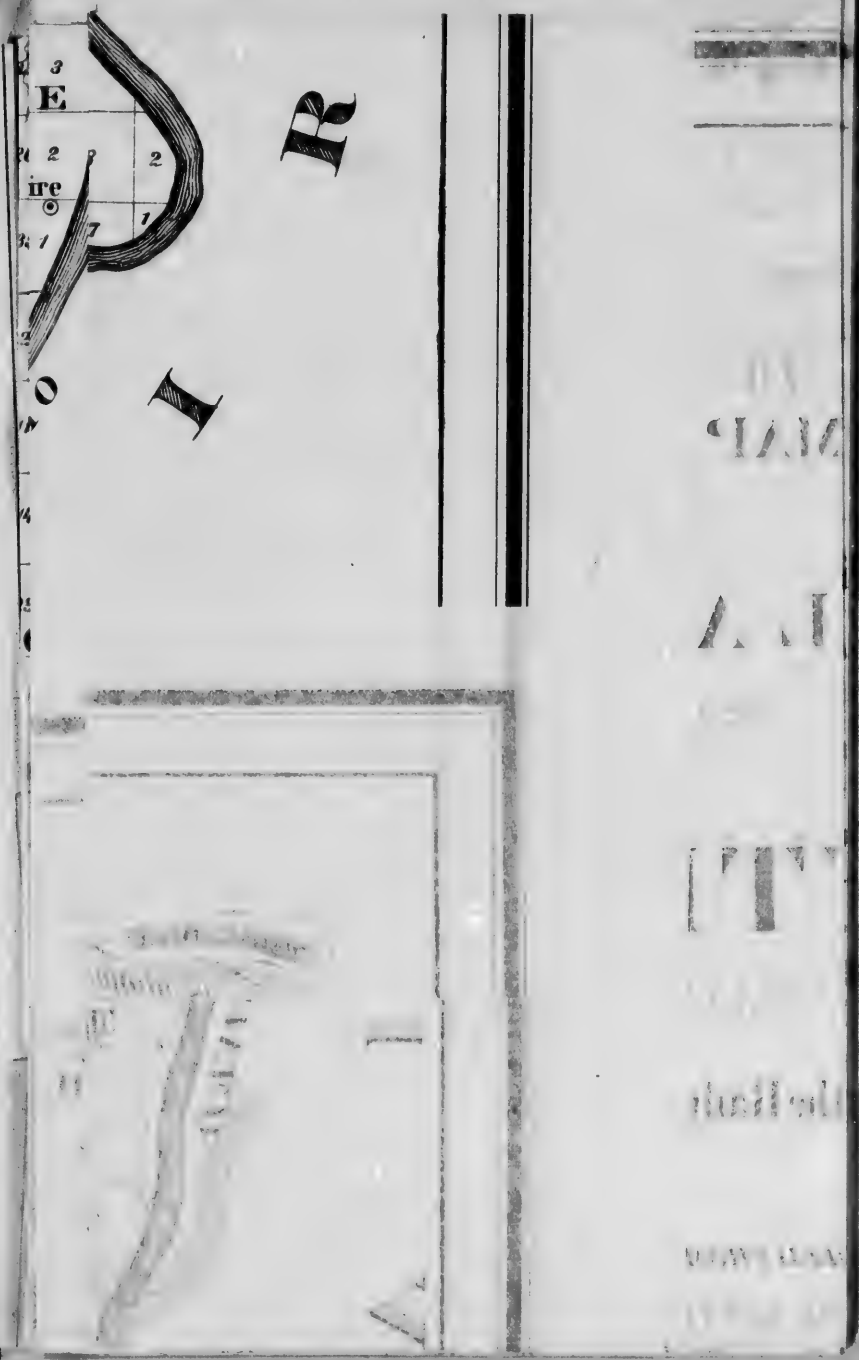
At Cleveland, the same amount of ore being $15.00, the coke from Connellsville costs in addition to eight cents a bushel or $4.00 a ton at Pittsburgh, the freight of $2.25 the ton or $6.25, making

* The coke which is made from the coal of Pittsburgh is largely used for foundry purposes. It weighs about thirty-three pounds to the bushel, and for iron-smelting the coke from the Connellsville coal, which weighs forty pounds to the bushel, is greatly preferred. Recent trials made at the Joliet Steel Works to purify, by washing, the sulphurous coals of northern Illinois, and convert them into a coke fit for metallurgical purposes, have been unsuccessful. The resulting coke was too porous for the blast-furnace, and the amount of sulphur could not be got below 1.76 per cent. (Terhune, Engineering and Mining Journal, April 25, 1874.)

for $1\frac{3}{5}$ tons, $9.75, which with the addition of $8.00, as before, would bring the cost of the ton of iron made from Lake Superior ores with Connellsville coke at Cleveland, to $32.75. Substituting $2\frac{1}{4}$ tons of Briar Hill coal, at an average price of $4.25, we have $9.56, which is nearly the same as for coke.

To points within the Hocking Valley coal-field distant 160 miles from Cleveland or from Sandusky, the ores of Lake Superior can be brought from these ports, at the ordinary rates of freight for coal over the Ohio roads, for $2.00 per ton, making the ore $11.00, or for $1\frac{2}{3}$ tons $18.33. If now we take three tons of coal at $1.50 a ton, we shall have, with the addition of $8.00 as before, $30.83. But to the iron-master, mining his own coal and building his furnace at the coal bank, the cost of the coal will be $1.00 a ton or less, which will reduce the cost of iron made from Lake Superior ores in the coal field, to $29.33 the ton. Substituting for the ores of Lake Superior the native ores, which mined on the land, will cost in some cases, as we have seen, not more than $2.50 to $2.75, and may be estimated at $3.00 the ton, we shall have for $2\frac{1}{2}$ tons of these ores, $7.50, which, with $3.00 for coal, and the addition of $8.00, as before, will give $18.50 for the ton of iron made in the coal-field with native ores. Comparing this with the lower estimate given at Milton, we may conclude that the price of iron thus manufactured in this region, will range from $16.00 to $18.00 the ton, and may, in many places, be still lower.

The coke, an admixture of which with the raw coal is in some cases found advantageous both in the Mahoning Valley and at Zanesville and Columbus, is now supplied from Connellsville. As already remarked, however, the Coal 7 of the Hocking Valley field promises to yield a good coke, while the lower four feet of the great Pittsburgh seam, so finely developed on Big Run (§ 12), has lately been found to give a coke of superior appearance, which is said to have been tried with excellent results at a furnace in Jackson county.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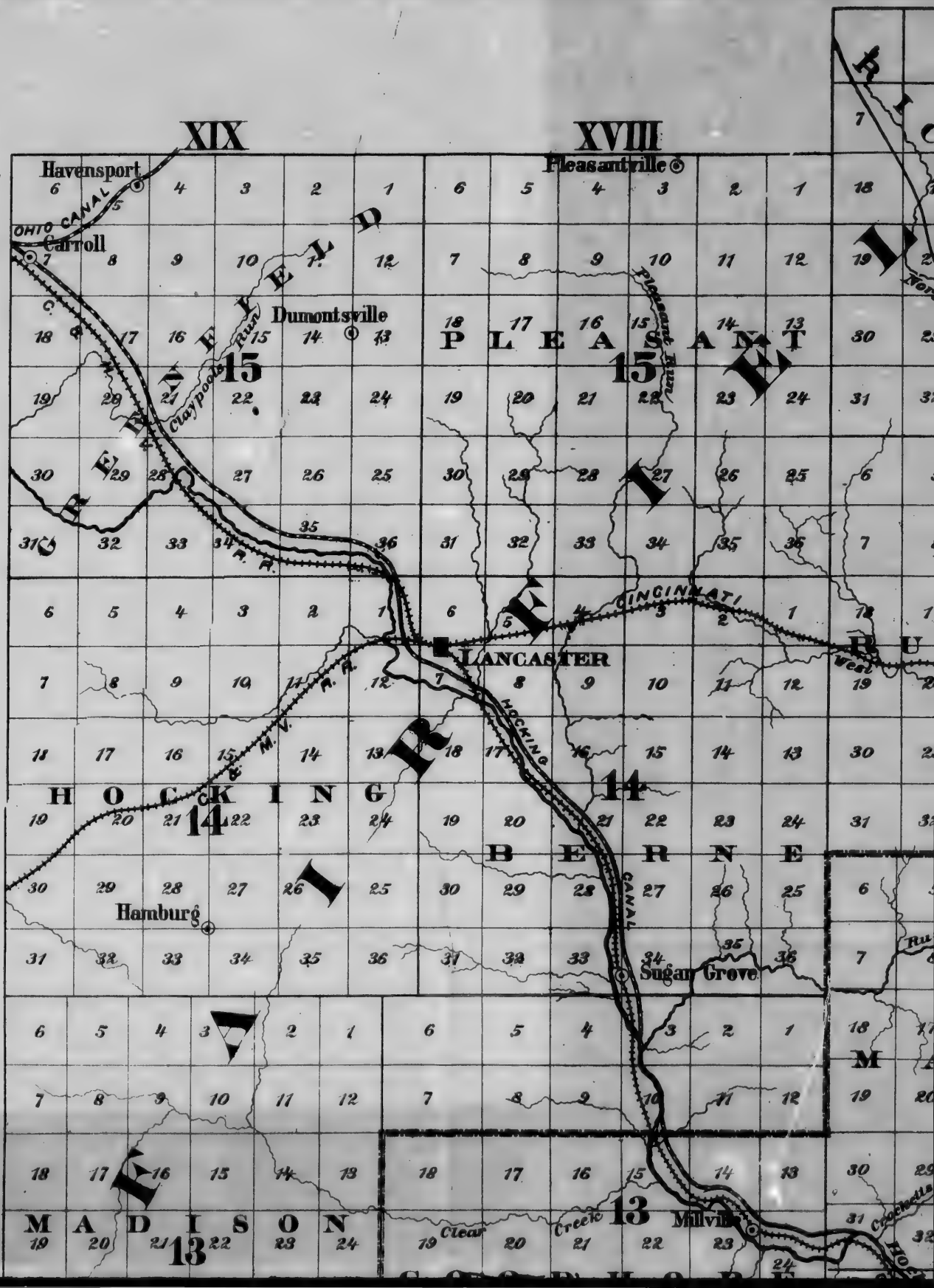
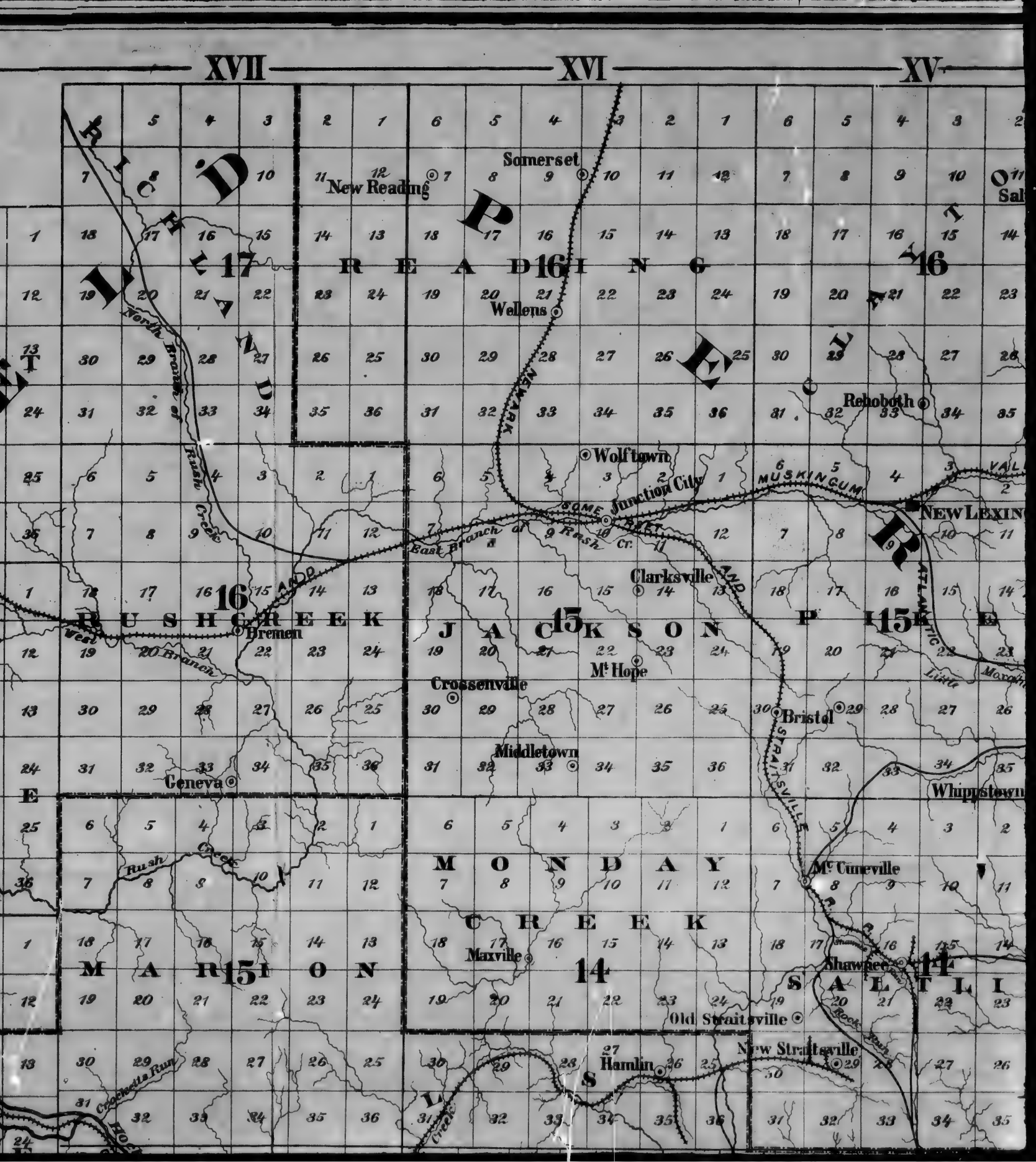
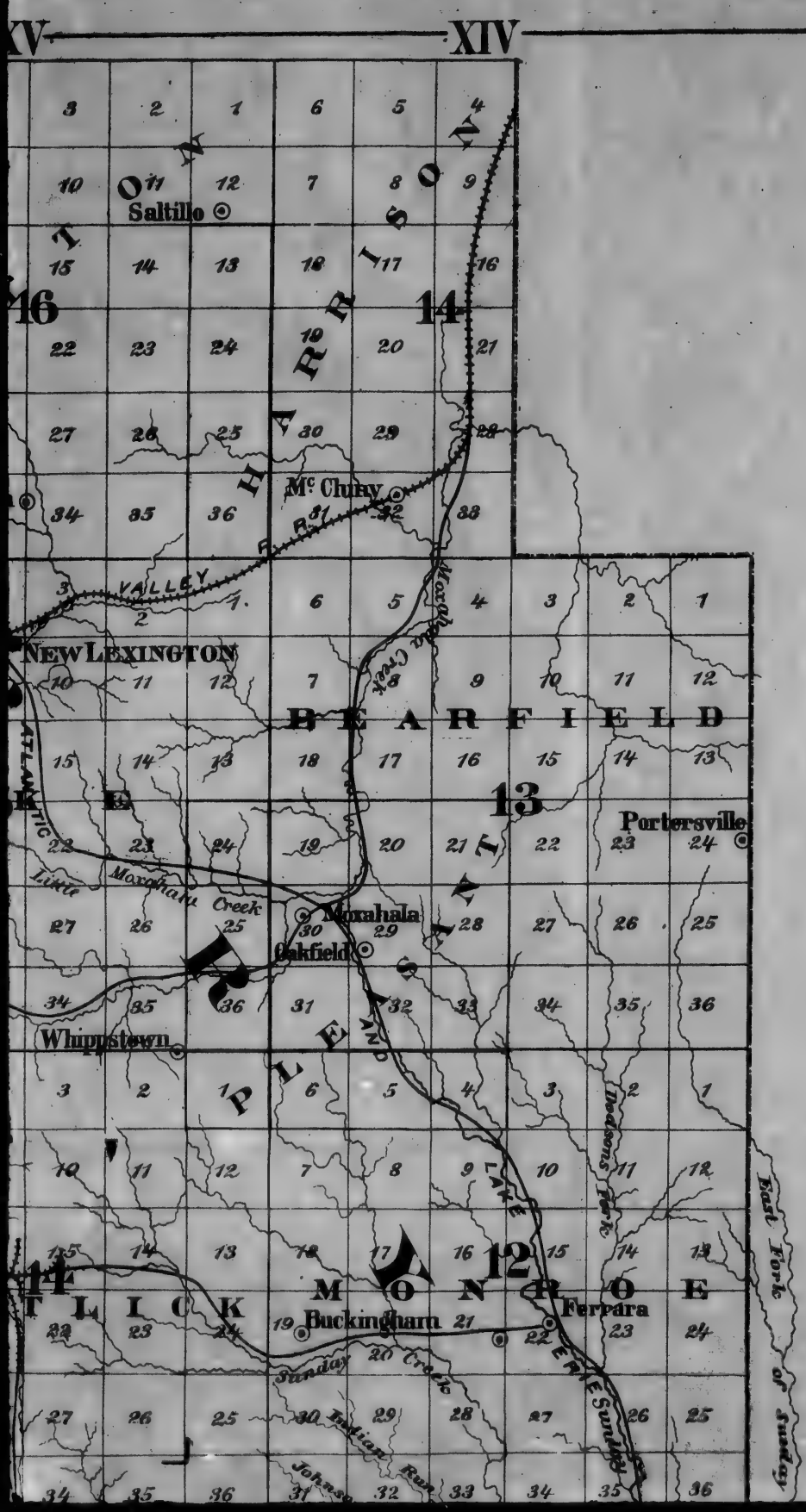

XIX
XVIII
Havensport
Pleasantville
OHIO CANAL
Carroll
FAIRFIELD
Dumontsville
Claypool Run
Pleasant Run
PLEASANT
15
15
C. & M. R. R.
LANCASTER
CINCINNATI
HOCKING
HOCKING
14
14
BERNE
Hamburg
CANAL
Sugar Grove
MADISON
13
13
Millville
Clear Creek


XVII
XVI
XV
Somerset
New Reading
Wellens
Rehoboth
Wolftown
Junction City
NEW LEXIN
Clarksville
Bremen
Crossenville
Mt Hope
Bristol
Middletown
Geneva
Whippstown
Mt Cureville
Maxville
Shawnee
Old Straitsville
New Straitsville
Hamlin
Rush Creek
North Branch of Rush Creek
East Branch of Rush Cr.
West Branch
Licking
Muskingum
Somerset
Newark
Zanesville
Straitsville
Atlantic
Licking
Rock
Crooked Run
READING
RUSH CREEK
JACKSON
PERRY
MONDAY CREEK
MARION
SALT LICK
16
15
14



MA

COAL

SOU

Showing the

COMPILED

BY

T.

MAP OF A PART OF THE

COAL AND IRON REGION

OF

OUTHERN OHIO

Showing the Railroads completed, in progress and projected.

COMPILED FROM THE MOST RECENT AND AUTHENTIC SOURCES

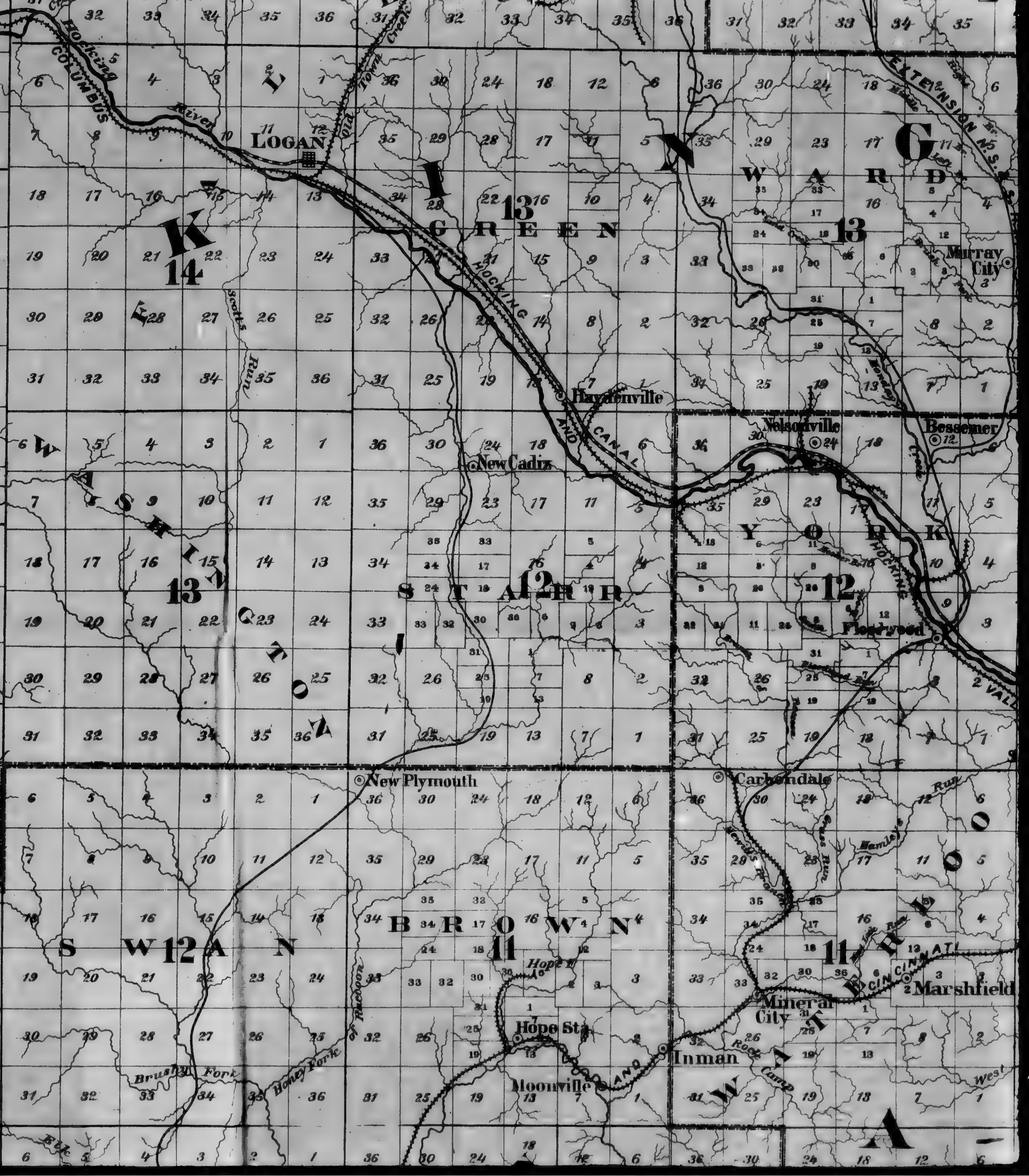
BY ISAAC B. RILEY C.E. NEWARK, OHIO.

DRAWN BY D.W. CURTIN

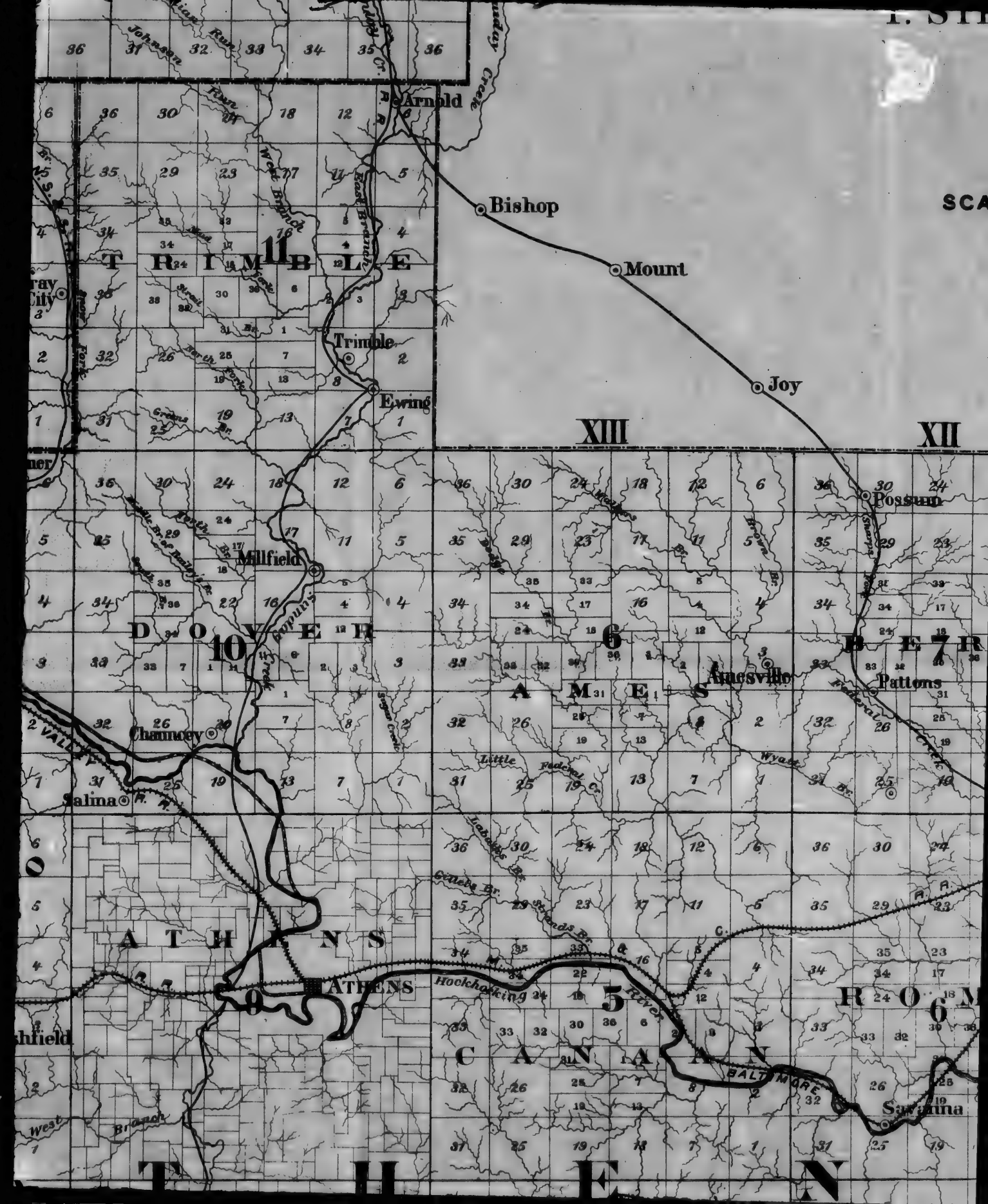
to accompany a report by

T. STERRY HUNT LL.D., F.R.S.


GOOD HOPE
PERRY
LAUREL
SALT CREEK
BENTON
JACKSON
EAGLE
Buena Vista
South Perry
Bloomingville
Locust Grove
Laurel Creek
Big Rocky Fork
Little Rocky Fork
Salt Creek
Pine Creek
Big Salt Creek
Clear Creek
Boon Run
Big Rocky Fork
Zanesville & Ohio
Columbus
Pomeroy & Columbus
Mid
13
12
11
10
9
8
7
6
5
4
3
2
1



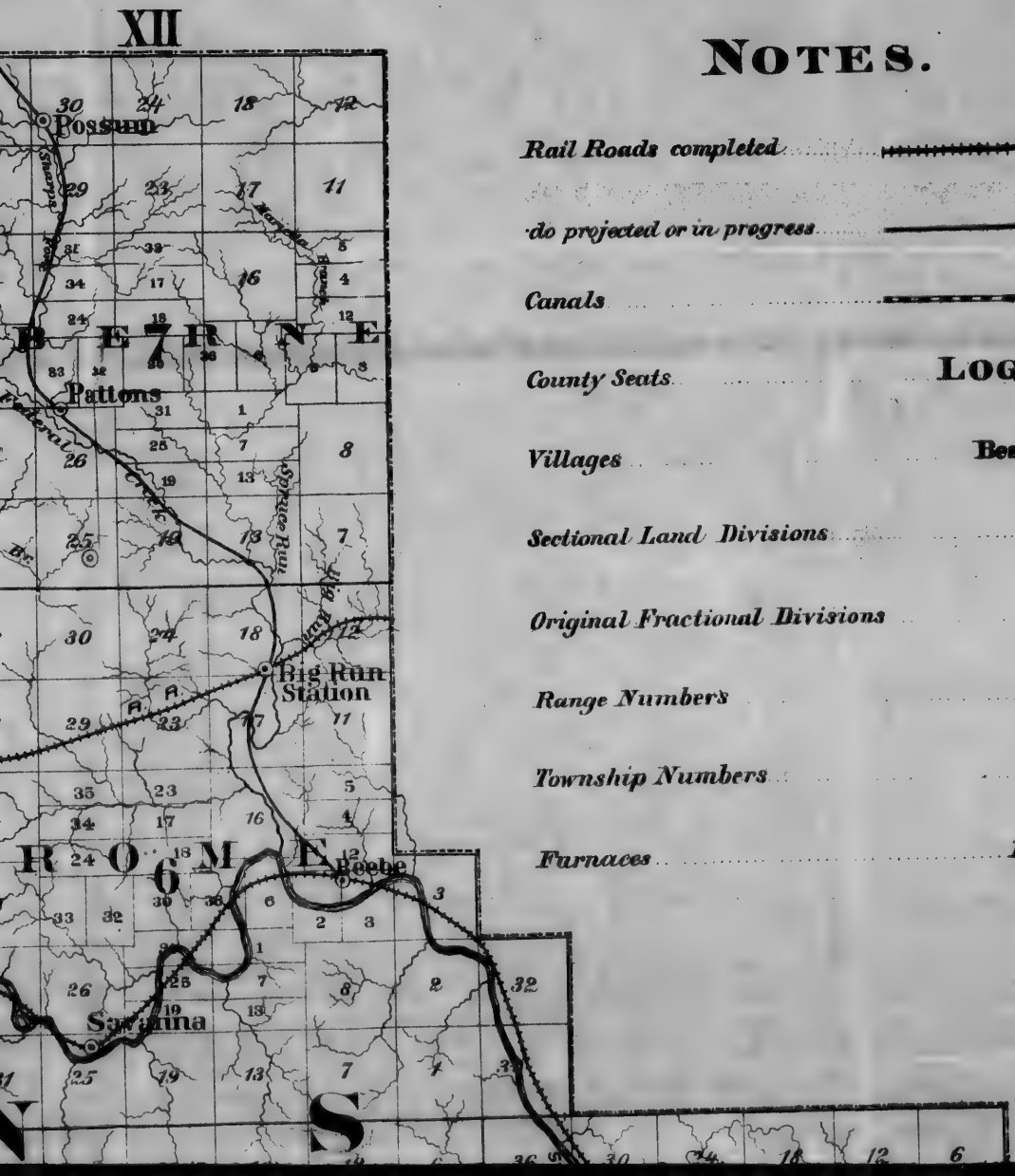
LOGAN
Hocking River
COLUMBUS
Old Town Creek
GREEN
13
FALLS
14
Scotts Run
HOCKING AND CANAL
Haydenville
Nelsonville
Bessemer
Murray City
WARD
EXTENSION
New Cadiz
WASHINGTON
STARR
12
YORK
Floodwood
New Plymouth
Carbondale
SWAN
BROWN
11
WATERLOO
Hope Sta
Moonville
Inman
Mineral City
Marshfield
CINCINNATI
Brushy Fork
Honey Fork
Raccoon
Hamleys Run
Rock Camp
VINTON


Arnold
Bishop
Mount
Joy
Trimble
Ewing
Possum
Millfield
Amesville
Pattons
Chauncey
Salina
ATHENS
ATHENS
CANAAN
Sawyna
XIII
XII
10
6
7
5
6

T. STERRY HUNT LL.D., F.R.S.

1874.

SCALE TWO MILES TO ONE INCH.



NOTES.

Rail Roads completed .....

do projected or in progress .....

Canals .....

County Seats ..... LOGAN

Villages ..... Bessemer

Sectional Land Divisions 16

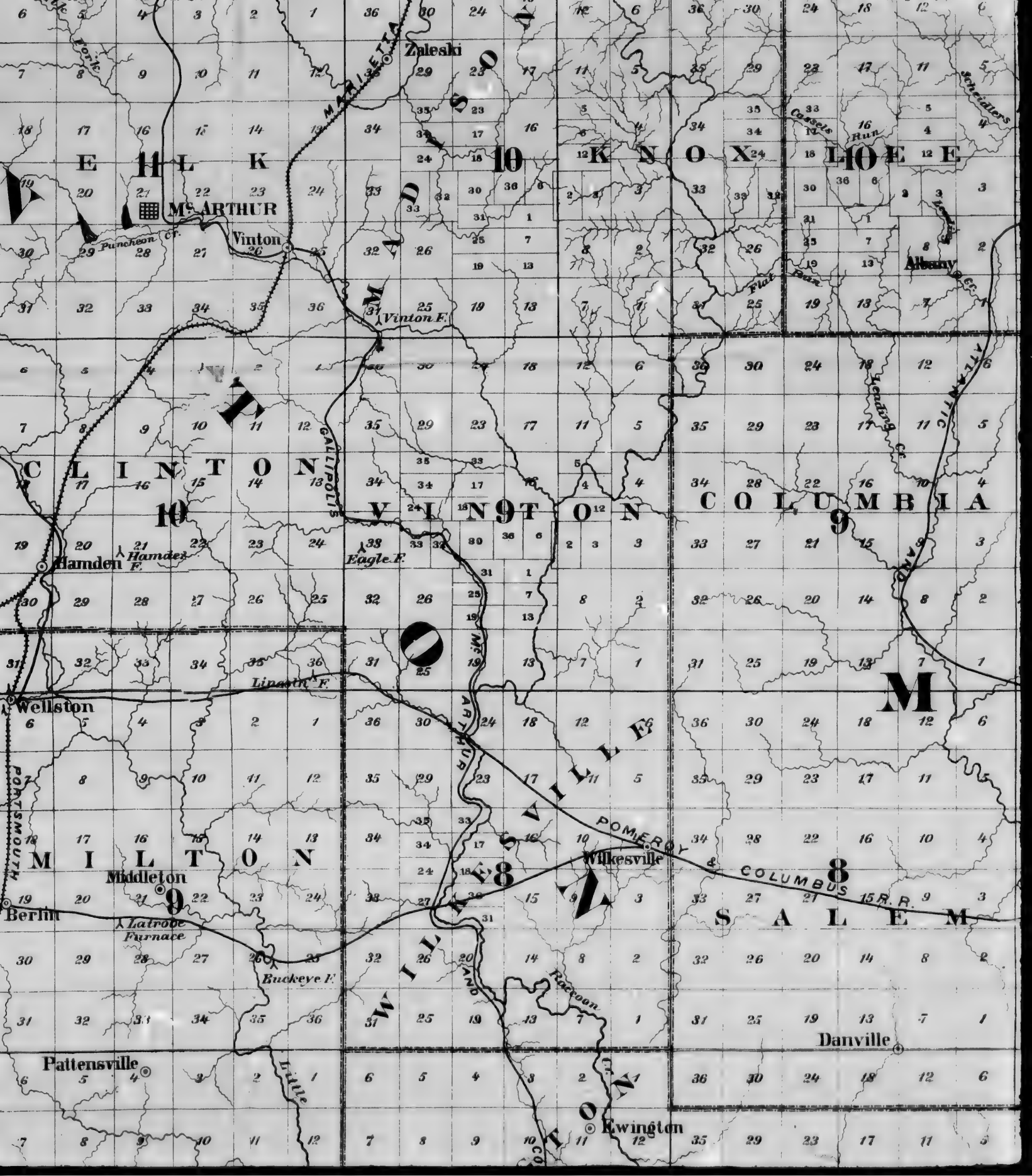
Original Fractional Divisions 20

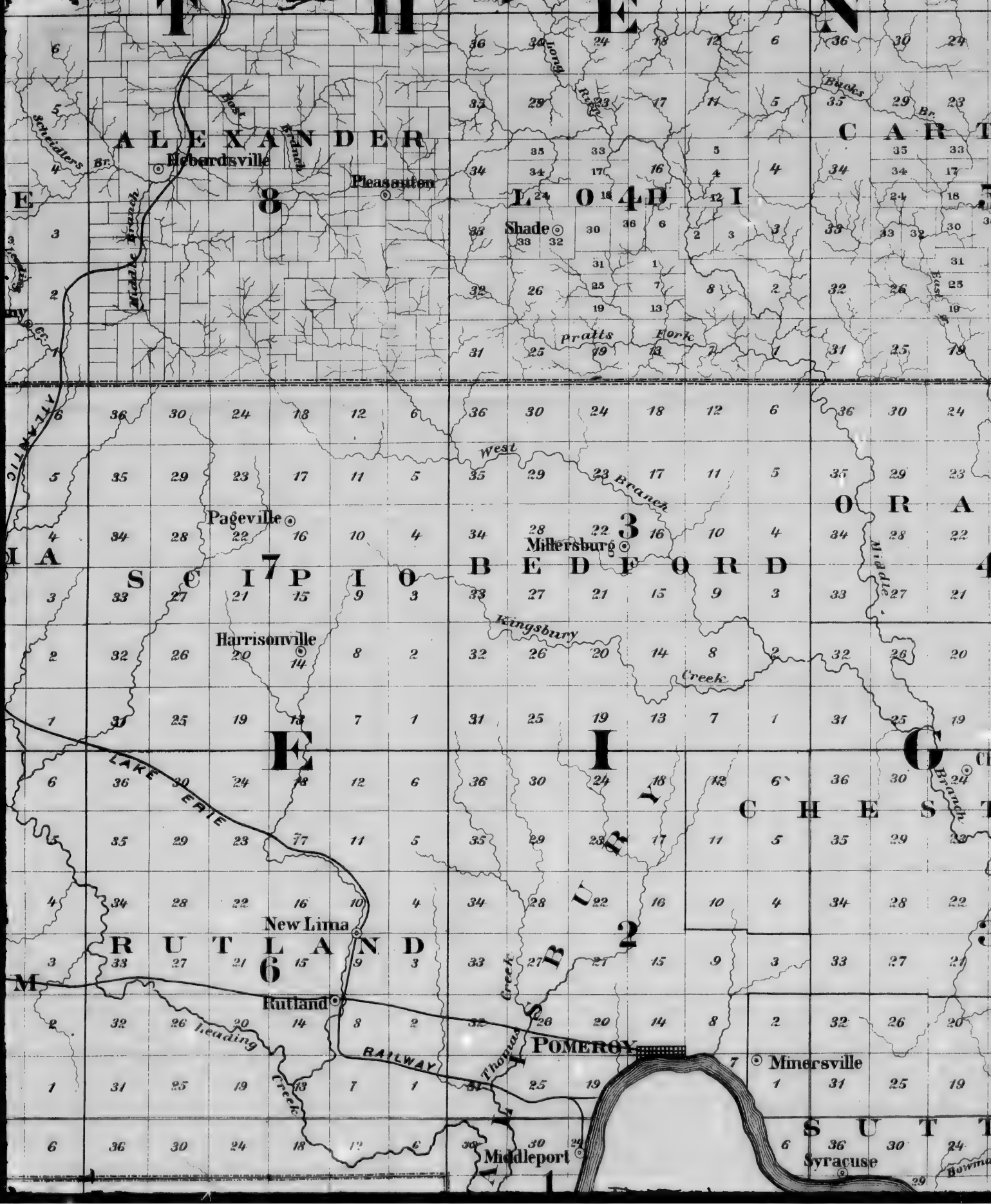
Range Numbers XIII

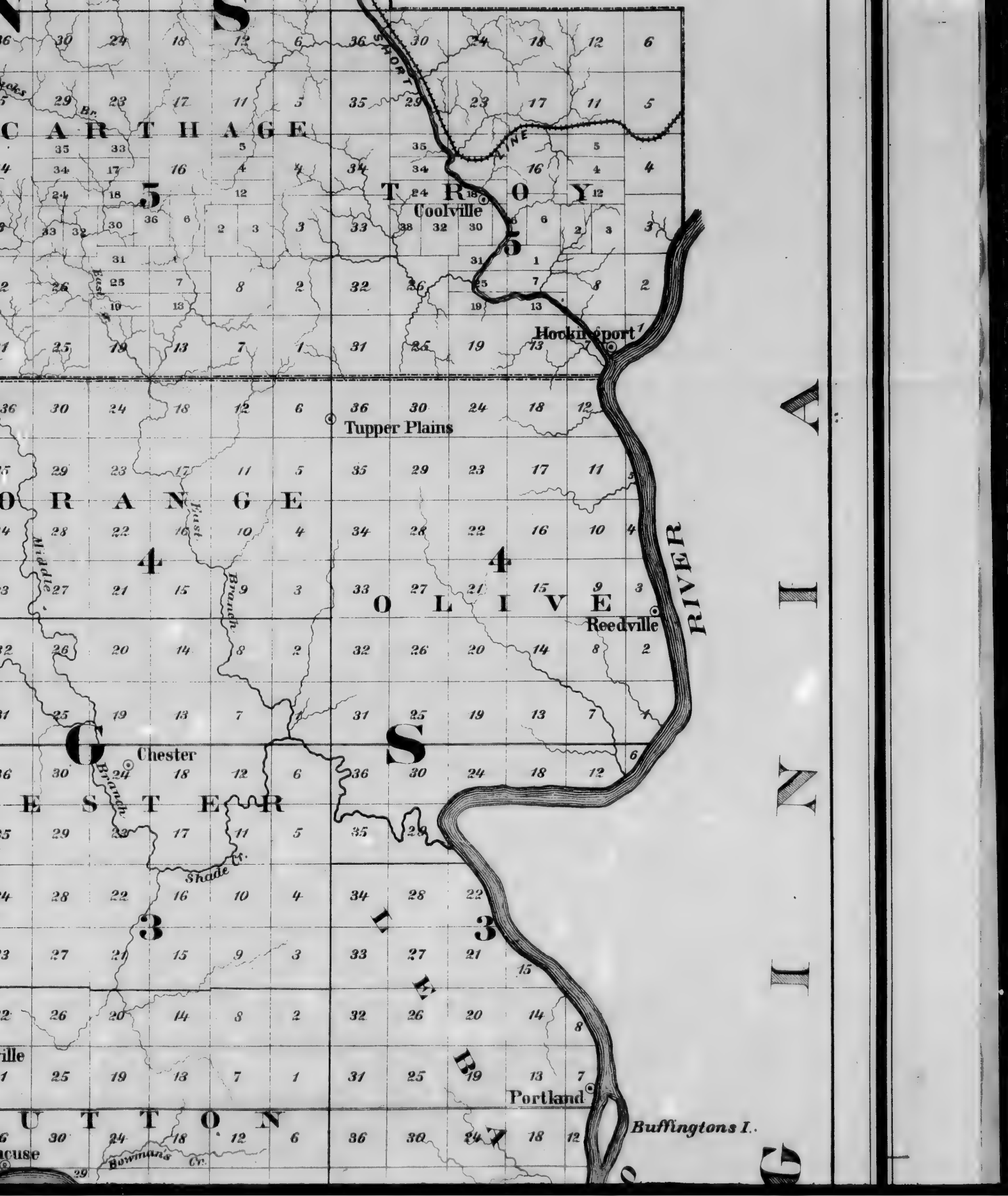
Township Numbers 10

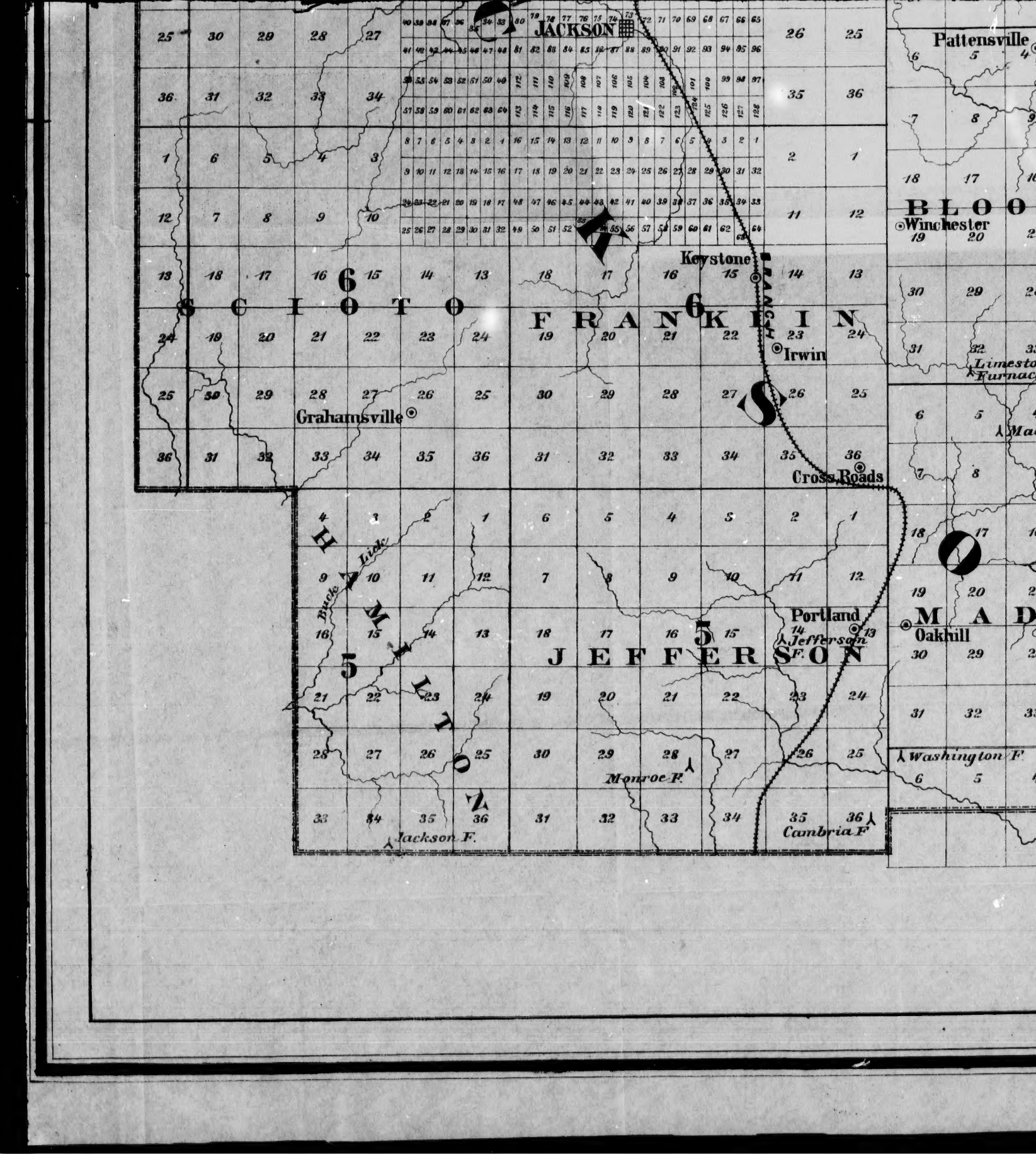
Furnaces ..... Hope


Salt Creek
Middle Fork of Salt Creek
Little Raccoon Cr.
Allensville
Ratcliffsburg
Raysville
Hamden
Swiftville
Wellston
Berlin
Pattensville
Portsmouth
HARRISON
RICHLAND
JACKSON
WASHINGTON
LIBERTY
LICK
JACKSON


Zaleski
MADISON
KNOX
LOEE
ELK
McARTHUR
Vinton
Puncheon Cr.
Vinton F.
Albany
Flat Run
Schriddler's Run
Cossels Run
CLINTON
VINTON
COLUMBIA
GALLIPOLIS
Hamden
Hamden F.
Eagle F.
Leading Cr.
ARTHUR
Wellston
Linsin F.
PORTSMOUTH
MILTON
Middleton
Berlin
Latrobe Furnace
Buckeye F.
WILKESVILLE
POMEROY & COLUMBUS R.R.
Wilkesville
SALEM
Raccoon
Danville
Pattensville
Little
Ewington

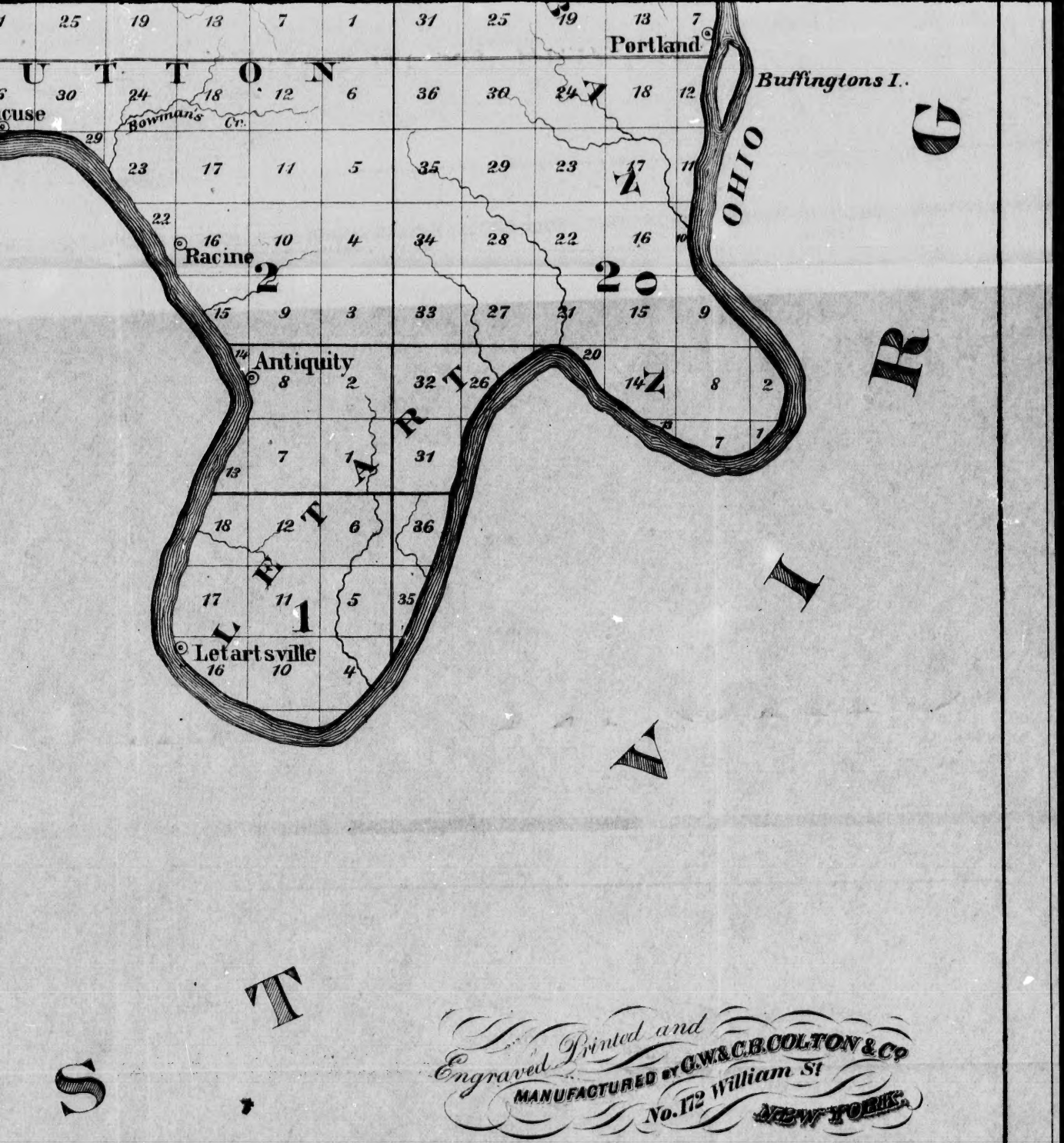

ALEXANDER
Hebardsville
Pleasanton
LOAD
Shade
Pratts Fork
Long Run
Buck
Schrader's Br.
East Branch
Middle Branch
ATLANTIC
West Branch
Pageville
Harrisonville
SCIPIO
Millersburg
BEDFORD
Kingsbury Creek
Middle
LAKE ERIE
New Lima
RUTLAND
Rutland
Heading Creek
RAILWAY
Thomas Creek
POMEROY
Minersville
Middleport
Syracuse
Branch
CHESTER
1
2
3
4
6
7
8


CARTHAGE
TROY
Coolville
Hockingport
Tupper Plains
ORANGE
OLIVE
Reedville
Chester
WESTERTON
LEBANON
Portland
Buffingtons I.
RIVER
OHIO
Shade R.
Bowmans Cr.
Middle Branch
East Branch
Short Line


JACKSON
Pattensville
Winchester
BLOO
Keystone
SCIOTO
FRANKLIN
Irwin
Grahamsville
Cross Roads
HAMILTON
JEFFERSON
Portland
Oakhill
MAD
Jefferson F.
Monroe F.
Washington F.
Jackson F.
Cambria F.
Buck Lick
Limesto
Furnac

Pattensville
Little
Danville
Ewington
Columbus
Raccoon
Township 7
BLOOMFIELD
Winchester
8
MORGAN
Vinton
Veja
Limestone Furnace
Carrigan
Creek
Madison Furn.
Porter
Creek
Township 6
RACCOON
SPRINGFIELD
Harrisburg
Centreville
Evergreen
MADISON
Oakhill
Indian Creek
Township 5
Wales
Rodney
Washington F.
GREEN


Middleport
Syracuse
Kaygerville
Cheshire
Addison
Fairhaven
GALLIPOLIS
Gr. Kanawha R.
OHIO RIVER
CHESHIRE
Kayger Cr.
George Cr.
Creek
1
2
3
4
5
W E S



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